

FULL MECHANICAL SYSTEM.

UNIVERSAL RELAY CALL INDICATOR CIRCUITS FOR INDIVIDUAL AND
TWO-PARTY JACK PER STATION OFFICES - METHOD OF OPERATION.

Universal Trunk Circuit -	ES-226552, Issue #9
Universal Control Circuit -	(ES-239787, " #2 (or (ES-239423, " #2
Numerical Lamps -	(ES-204479, " #2 (or (ES-195395, " #6
Timing Circuit	ES-239786, No issue listed.

GENERAL:

Section V-D contains a detailed description of the operation of the universal relay call indicator circuits for four-party jack per line offices as well as a general description of relay call indicator equipment.

This section (V-J) covers the operation of universal circuits for individual and two-party jack per station offices.

The universal trunk circuit shown on ES-226552 can be adapted by changes in wiring (indicated on the drawing) for -

R.C.I. operation without team work.
R.C.I. operation with team work.
Call wire operation.

This circuit is the same as the four-party circuit shown on ES-239423 except that the party ringing equipment is replaced by individual line ringing equipment.

In addition to the above, either metallic or ground circuit supervision may be specified as required and different repeating coils for various conditions of loading and for 24-volt and 48-volt transmission.

The control circuit shown on ES-239787 is arranged to operate with either two or three wire office selectors and can be converted for universal pulsing (6500 ohm discriminating resistance) by substituting the proper marginal and polarized relays. When this has been done the circuit will be the same as shown on ES-239423 and described in Section V-D.

Circuit Operations - R.C.I. without Team Work:

After the trunk has been selected at the machine switching office and the subscriber has completed dialing, the winding of the TG relay of the sender in the machine switching office is connected across the tip and ring of the trunk toward the manual office, causing this relay to operate in series with trunk relay A.

At the machine switching office, relay TG prepares the sender circuit so that the relay call indicator impulser will start as soon as the operator in the manual office depresses the display key of the trunk.

At the manual office, relay AL operates and locks up to ground at front contact of A relay.

Trunk assignment lamp lights steadily - circuit closed by AL relay.

When the operator depresses the display key of the trunk the following operations take place:

Relay HO (control circuit) operates in series with relay K of trunk.

Circuit: Battery, winding HO Ry., back contact
SL relay, winding K Ry., front contact
AL relay, contact of display key, back
contacts IC and PC Rys., ground.

Relays HO and K lock up independently of the key contacts.

Trunk relay K-1 operates - front contact K relay.

Trunk relay LM operates - front contact K-1 and AL relays.

Trunk relay I operates in series with relay IC (control) - circuit closed by LM relay.

The operation of relay I opens the tip and ring sides of the trunk circuit, allowing trunk relay A and sender relay TG to release.

Trunk relay AL releases (circuit opened by A relay) and removes the short circuit from relay RC, allowing it to operate in series with winding of LM relay which remains operated. The release of relay AL also changes the steady assignment signal to a flashing signal as an indication that the number to be displayed belongs to that trunk.

Relay I connects the marginal and polarized relays of the control circuit across the tip and ring sides of trunk toward the machine switching office so that they will respond to the pulses received.

As a result of the release of sender TG relay, the relay call indicator impulser at the machine switching office starts from normal and makes a complete revolution, sending out the proper pulse

codes to display the called number on the indicator.

The operation of relay IC mentioned above opens the circuit to ground on back contacts of relay PC, so that should the operator hold the display key down longer than necessary relay KC will operate and prevent the displayed number from disappearing, or should she depress another display key accidentally or intentionally before the number has been displayed the operation of relay KC will allow the number to be displayed and prevent it from disappearing until either the key has been released and depressed again or the cord has been plugged into a working jack.

Reference to the circuit drawings of the control and lamp circuits will show that the pulse code for any digit or letter is divided into four parts with the following pulse combinations:

Part #1 - Positive pulse or open circuit.

Part #2 - Light or heavy negative pulse.

Part #3 - Positive pulse or open circuit.

Part #4 - Light or heavy negative pulse.

Each code always contains two negative pulses and may contain a positive pulse in either the first or third part, but not in both parts. Positive pulses are always light.

The relays of the control circuit which respond to these pulses are as follows:

(+SN) Relay - Responds to positive pulses.

(-SN) Relay - Responds to light or heavy negative pulses.

MG Relay - Responds to heavy negative pulses.

The control circuit shown on ES-239787 is provided with two marginal relays adjusted to operate over two of the following loop resistances:

0	to	800	ohms
800	"	1700	"
1700	"	2100	"
2100	"	2600	"

With this arrangement it is necessary, of course, to terminate at a given position only trunks with loop resistances falling within the limits set for the marginal relays of that position. The circuits are so arranged that the depression of a trunk display key will connect in the MG relay corresponding to the loop resistance of the trunk.

The above applies to circuits which are to work in connection with full mechanical senders which are not arranged for universal pulsing: i.e., with senders having 3500 ohms discriminating resistance. When the senders have been arranged for universal pulsing (6500 ohms discriminating resistance) the marginal relays will be replaced by one relay which can be adjusted to operate satisfactorily over the various loop resistances up to 2600 ohms.

The five groups of lamps on the indicator have associated with them lamp relays designated as follows:

<u>Lamps</u>	<u>Relays</u>
Ten thousands	A
Thousands	A-1, B-1, C-1, D-1.
Hundreds	A-2, B-2, C-2, D-2.
Tens	A-3, B-3, C-3, D-3.
Units	A-4, B-4, C-4, D-4.

The selection and lighting of a particular lamp in a group depends upon the operation or non-operation of these relays. Thus, if no relays are operated, #0 lamp will light; if only the A relay is operated #1 lamp will light, etc.

The lamp relays operate under the following conditions:

- A Relay - Positive pulse in 1st part of code.
- B " - Heavy negative pulse in 2nd part of code.
- C " - Positive pulse in 3rd part of code.
- D " - Heavy negative pulse in 4th part of code.

Associated with each group of lamp relays is a pair of switching relays for switching the control leads from one group of lamp relays to the next. The operation of these relays is entirely under the control of the W and Z relays which go through a four-step cycle of operation as a result of the two negative pulses contained in each code.

The pulse codes are sent out in the following order:

Ten thousands
Thousands
Hundreds
Tens
Units

In this explanation we will assume that the number being called is 3765. As the ten thousands code is the first one to be sent the first pulse will be a light negative, causing the (-SN) relay to operate. The operation of the (-SN) relay causes the operation of the N relay through its 200-ohm winding and the marginal winding of Z relay; the latter cannot operate during the period of the pulse as the active winding is short-circuited. At the end of the pulse, relay (-SN) releases and removes the short circuit from the active winding of Z relay so that it operates and relay W remains operated.

It will be noted that with relay W operated a circuit is closed to operate relay ST; this circuit is continued by the operation of the Z relay so that as long as either relay, W or Z, is up relay ST remains operated, but relay ST-1 cannot operate on account of being short-circuited.

The next pulse, which is the last ten thousands pulse, is a light negative in the fourth part of the code, causing the (-SN) relay to operate again. Relay W then releases, being short-circuited by ground from contact of the (-SN) relay; the Z relay, however, remains operated until the (-SN) relay is released at end of pulse. The release of Z relay removes the short circuit from ST-1 relay, allowing it to operate and lock up in series with the ST relay.

The operation of the W, Z, ST and ST-1 relays has switched the control leads from the ten thousands lamp relays to the thousands lamp relays which are ready to operate as required by the pulse code for the thousands digit.

It will be noted that the ten thousands lamp relay A did not operate, as no positive pulse was received to operate the (+SN) relay.

The lamp relays to be operated for the remaining digits of the called number are as follows:

#3 Thousands	-	A-1, D-1
#7 Hundreds	-	B-2, D-2
#6 Tens	-	A-3, D-3
#5 Units	-	D-4

The control leads are switched from one group of lamp relays to the next by the associated switching relays in the same manner as described above with the result that after all pulses have been received all of the switching relays will have been operated and locked up.

The circuits for supplying current to light the indicator lamps are closed as follows:

Thousands and Hundreds Lamps	- Operation of LL Ry. by T Ry.
Tens Lamps	- Operation of U Ry. on first negative pulse of units code.
Units and Ten Thousands Lamps	- Operation of DO Ry.

NOTE: When circuits are wired with strap (a) at U-1 Ry. the operation of DO Ry. occurs at same time as that of U Ry. This strap is omitted when two-wire office selectors are involved so that operation of DO Ry. is dependent upon the heavy positive pulse sent to advance the office sequence switch after all call indicator pulses have been received.

In this explanation we will assume that a three-wire office selector is being used, requiring the use of strap (a) at U-1 Ry. as mentioned above. In this case, therefore, the PC relay operates and locks up in series with DO relay at the end of the last units pulse. Relay PC closes a circuit to operate the position register and opens the circuit of the I and IC relays.

The release of relay I disconnects the trunk from the control circuit and re-establishes the circuit of the A relay.

At the machine switching office after the relay call indicator impulser has completed its revolution, talking selection is made by the district circuit, the sender is released and trunk closure takes place as described in section V-B.

The CS relay of the district circuit is then connected across the trunk, causing trunk relay A to operate. CS relay does not operate on account of wrong direction of current.

Relay LM releases, being short-circuited by ground from A relay contacts. Relay RC, however, remains locked up to ground at front contacts of A relay.

The operator tests the line for busy in the regular way and if line is idle, completes the connection by plugging the cord of the trunk into the subscriber's multiple jack. This results in the operation of the SL and R-2 relays.

Relay SL opens the circuit of relays K and HO. Relay K in releasing, opens the circuit of K-1 relay, allowing it to release and open the circuit of the assignment lamp. The release of HO relay opens the common ground connections for all control circuit and lamp relays which were locked up, causing them to release and extinguish the indicator lamps. The control circuit is now ready to handle another call.

Relay SL also switches the tip side of the cord from the busy test circuit to one side of the ringing current.

Relay R-2 closes through both sides of the ringing circuit and opens the short circuit around the .02 M.F. condenser in ring side of the talking circuit, so that ringing tone is connected through the condenser to ring side of the repeating coil for the purpose of giving ringing induction to the calling subscriber.

When the called subscriber answers, relay R-1 operates over the circuit closed by his instrument, removing the shunt from winding of R-3 relay and allowing it to operate. Relay R-3 short-circuits relay R-2, causing it to release and cut off the ringing current. Relay R-2 in releasing also closes the talking circuit from the subscriber's line to the trunk repeating coil and battery.

Relay S then operates over the subscriber's line, closing circuit to operate relay S-1, which in operating reverses the direction of current flow over the trunk so as to cause the operation of polarized CS relay in the district circuit at the machine switching office.

DISCONNECTION:

When the calling subscriber hangs up, the selectors in the machine switching office are released and the trunk circuit to the manual office is opened, causing the release of trunk relays A and RC in turn. Relay RC opens the locking circuit of relay R-3, allowing it to release.

The disconnect lamp has been shunted out up to this time, first by the winding of R-2 relay during ringing and then by winding of R-3 during talking, but now that the shunt is removed the lamp lights as a disconnect signal. The operator then removes plug from jack, opening the circuit of the SL relay and disconnect signal.

TRUNK SELECTED WITH PLUG IN MULTIPLE:

A trunk that has been released from a connection at the machine switching office can be selected again to complete another call whether or not the plug has been removed from the multiple jack at the call indicator position after the completion of a previous call. When the selector at the machine switching office releases the trunk, the circuit of the A relay is opened, causing this relay and relay RC to release in turn. The release of RC relay opens the shunt around the disconnect lamp; permitting it to light in series with the sleeve relay. When the trunk is selected again relay A operates and closes a circuit to operate the AL relay, which causes the assignment lamp to light.

The operator seeing both the disconnect and the assignment lamps lighted knows that the previous connection has been completed and that a new call is waiting to be displayed. She accordingly removes the plug from the multiple jack and depresses the display key of the trunk, causing the new number to be displayed in the regular way. The display key of a trunk is ineffective when the plug is up in the board, as the circuit for operating the K relay is held open at back contacts of SL relay.

WIPE OUT OF DISPLAY BY SECOND DISPLAY KEY:

The circuit conditions after a number has been displayed but before the trunk has been plugged up or another display key depressed, are as follows:

Relay A operated by trunk closure at machine switching office.

Relay RC is locked up to ground at front contact of relay A.

Relay HO (control circuit) and relay K (trunk) are locked up in series.

Relay K-1 is operated - circuit closed by K relay.

Assignment lamp is flashing - circuit closed to interrupter by K-1 relay.

Relays I and IC are released, the circuit having been opened by the operation of PC relay after last pulse.

The depression of the display key of another trunk on which the assignment lamp is lighted establishes the following circuit:

Battery, winding of previously operated HO Ry., back contacts SL relay (second trunk), winding K Ry., front contacts AL Ry., display key contacts, winding HO-1 Ry., back contacts KC Ry., front contacts PC Ry., ground.

This circuit closure shunts the KC relay of the first trunk by the parallel circuit through low resistance windings of K relay (second trunk) and HO-1 relay (control circuit), causing the release of relay K (first trunk) which disconnects the first trunk from the control circuit. Relay K-1 (first trunk) then releases and causes the assignment lamp to light steadily again.

Relay HO-1 operates and closes a circuit to operate HO-2 relay, which locks up to ground at front contacts of PC relay. Relay HO-2 opens the common ground connections of the control circuit, causing the release of all relays depending upon them and extinguishing the indicator lamps.

Relay PC in releasing opens the circuit of HO-1 relay, causing the release of this relay and of HO-2 relay in turn. The opening of this circuit allows relay K of the second trunk to lock up in series with relay HO. The number being called over the second trunk is then displayed on the indicator in the regular way.

SECOND DISPLAY KEY DEPRESSED BEFORE NUMBER IS DISPLAYED:

If a second display key is depressed before the indicator lamps have displayed the number for the first call, the displaying of the first number will not be interfered with.

Relay HO of the control circuit and relay K of the first trunk will have been operated in the regular way by depression of the first display key. Trunk relay I of the first trunk and relay IC (control circuit) also will have been operated. As the number has not displayed, relay PC of the control circuit will not have operated, so that the depression of the display key of another trunk on which the assignment lamp is lighted will close a circuit to operate KC relay (control circuit) as follows:

Battery, winding of previously operated HO Ry.,
back contacts SL Ry. (second trunk), winding
K Ry., front contacts AL Ry., contacts of
display key, winding KC Ry., ground.

The K relay of the second trunk will not operate, due to high resistance winding of KC relay. The operation of KC relay, however, holds open the circuit of HO-1 relay so that it cannot operate when relay PC operates after the last pulse has been received. In this way the number being called over the first trunk is allowed

to be displayed and to remain displayed until either the second display key is released and depressed again or the trunk has been plugged up in the board.

RELAY CALL INDICATOR WITH TEAM WORK

If the team work display key is depressed on a trunk with a steady assignment signal, control relay HO of the adjacent position to the right or left (depending upon location of trunk on position) will operate in series with trunk relay KA, which has the same functions in connection with the adjacent control circuit as relay K has with the home control circuit.

Relays IA and KB in parallel then operate in series with relay IC of the adjacent control circuit. The operation of relay KB switches the busy test of the trunk from the home operator's telephone set to the adjacent operator's telephone set; it also switches the circuit of the assignment lamp from the busy back interrupter to the peremptory disconnect interrupter, which causes the lamp to flash at a faster rate than when the home display key is used. This indicates to the home operator that the adjacent operator is handling the call on that trunk. As a result of depressing the team work display key the called number will be displayed on the indicator of the adjacent position.

Aside from the above, the circuit operations are the same as described for relay call indicator without team work.

OPERATION OF CONTROL CIRCUIT WITH TWO-WIRE OFFICE SELECTORS:

When two-wire office selectors are used a heavy positive pulse is required after the series of call indicator pulses for the

purpose of advancing the office sequence switch to the talking position.

The operation of relay U-1 at the end of the last call indicator pulse connects the winding of the (-SN) relay in parallel with 250 ohms resistance across the tip and ring conductors of the trunk. This relay is connected to the trunk in the reverse direction so that it will respond to the positive pulse which is sent by the impulser in the machine switching office. The operation of the (-SN) relay causes the following circuit to operate relay DO:

Ground, front contacts (-SN) Ry., front
contacts U-1 Ry., winding DO Ry., battery.

At the end of the pulse, relay (-SN) releases and allows relay PC to operate and lock up in series with relay DO.

In this way the units and stations lamps are not lighted until the positive pulse has been received, and the display cannot be wiped out by the depression of another display key until the end of the positive pulse.

When a call indicator position has trunks, some of which are reached through two-wire office selectors and the remainder through three-wire office selectors which do not require the heavy positive pulse, the control circuit is provided with a timing circuit which becomes effective on calls from three-wire office selectors. The timing circuit is shown on ES-239786 and is connected to leads A, B and C as indicated on the control circuit.

The operation of the timing circuit is as follows:

As soon as relay T operates on first negative pulse of tens code, it connects ground to lead A to operate slow release

relay PA. When U relay operates on first negative pulse of units code it connects ground to lead B to operate relay PB through front contact of relay PA.

Relay PB locks up to ground on lead A and opens the circuit of relay PA, allowing it to release. When PA relay releases it connects lead B through front contacts of PB relay to lead C, operating relays PC and DO in series. Relays PC and DO lock up in same way as described above.

CALL WIRE OPERATION:

General:

Trunks terminating at a call indicator position can be converted by means of certain wiring changes for use as call circuit trunks. If desirable, part of the trunks on a position can be arranged for call indicator operation and the rest for call circuit operation. This makes it possible to install call indicator equipment previous to the time of cutover of a distant office from manual to machine switching operation. The wiring is so arranged that the conversion from call circuit operation back to call indicator operation can be made on the night of the cutover of the distant office.

The trunks are arranged for keyless operation and are handled in exactly the same way as regular manual keyless trunks.

CIRCUIT OPERATIONS:

When the "A" operator plugs into the trunk assigned, relay A operates and closes a circuit to operate RC relay.

The guard or assignment signal then lights unless the "B" operator has plugged into a jack with the trunk cord.

Circuit: Battery, assignment lamp, back contact AL Ry., back contact SL Ry., front contact RC Ry., ground.

When the "B" operator puts up the cord, relay SL operates and opens the circuit of the assignment lamp, which goes out.

Relay SL cuts off the busy test and connects ringing ground to tip side of cord through front contact of R-2 relay, which operates in series with SL relay and acts as a shunt for the disconnect signal.

Relay R-2 also connects ringing current to the ring side of the circuit to ring the called subscriber and to give the audible ringing signal to the calling subscriber.

When the subscriber answers, relay R-1 operates and removes the short circuit from winding of R-3 relay which operates in series with R-2 relay and then closes a short circuit to release R-2 relay.

The release of relay R-2 opens the ringing circuit and closes the talking circuit so that relay S operates over the called subscriber's line and completes a circuit to operate the "A" operator's supervisory relay.

When the "A" operator disconnects, relays A, RC and R-3 release in turn and the disconnect signal lights, due to the opening of the shunt circuit at front contact of RC relay. Disconnection by the "B" operator releases SL relay and extinguishes the disconnect signal.

LAYOUT, TRUNK ARRANGEMENT, DESIGNATION, ETC.

The amounts of the various kinds of apparatus which make up a full mechanical central office are determined by the number of lines to be served, by the volume of traffic, and by the length of time the connection is held. The manner in which these kinds of apparatus are connected with respect to each other, also depends upon the traffic conditions. There are, moreover, certain standard arrangements for grouping together apparatus of one kind, as for example, the wiring of the multiple banks of line switches on one shelf.

Line Switches

One line switch is required for each working line, and about 5% spare are required for the office to give flexibility in distributing the load. The line switches are arranged in groups corresponding to the various classes of service, such as message rate individual, message rate party, coin box, and flat rate. They are mounted in shelves of 20 switches each, on a framework which normally has a capacity for 9 shelves, or 180 switches. The line and cutoff relays are mounted on the same shelf and directly below the line switches with which they are associated. The switches on each line switch frame are numbered consecutively beginning with 0 at the upper left hand corner, numbering horizontally, and ending with 179 at the lower right hand corner. Twenty sets of the multiple bank terminals of each line switch are multipled through the multiple bank terminals of all the other line switches on the shelf; and the 20 multiple banks thus wired together are connected to 20 district

selectors. Twenty district selectors will handle traffic for more than 20 line switches, usually in the ratio of 4 to 10 shelves of 20 line switches to 20 district selectors, depending on the rate at which the subscribers originate calls and the length of time the connections are held; and a number of shelves are consequently multiplied together and connected to one group of 20 district selectors. The multiple banks of the shelves which are to be served by the same 20 district selectors are connected together by multiple cables.

As the line switch always returns to the normal position after being used, it is evident that if the district selectors were multiplied straight through the line switch multiple banks on a shelf, the district selector on terminal #1 would be used most frequently, the district selector on terminal #2 next, and so on. In order to cut down the length of time required for a line switch to find an idle district selector, and to obtain the maximum efficiency from the district selectors, the line switch multiple on each shelf is "slipped"; that is, the district selector connected to terminal #1 on the first switch is connected to terminal #2 on the second switch, to terminal #3 on the third switch, etc. With this arrangement, the trunks to the district frames are equally likely to be selected, and the average length of time required to associate a calling subscriber's line with an idle district selector is reduced to a minimum. In order to avoid the crossing of wires leading to the multiple terminals, using the slipping scheme, a terminal strip is installed at each end of the shelf and the leads from each terminal strip are extended through approximately one half the terminals of the switches on the shelf, as shown on the accompanying sketch "A".

Local cabling is run from the terminal strip on one end of the shelf to the terminal strip on the other. This wiring has no relation to the local traffic condition and will, therefore, be permanent regardless of other rearrangements that may be made subsequently.

Shelves which are to be cabled together may be either multiplied straight or may have a slip arrangement between shelves. In the former case, the trunks to the district selectors appear in the same location on the corresponding switch of each shelf, that is, the district selector connected to terminal #19 on the terminal strips on one shelf, will also be connected to terminal #19 on the terminal strips of all the other shelves of the group. When there is a slip arrangement between shelves, the slip within all multiple banks is the same, but the district selectors are connected to different terminals on the terminal strips of different shelves. The method of slipping between shelves follows an arrangement which allows the same type of cable form to be used in multiplying all shelves together regardless of the number of shelves per group. Sketch "A" shows the slipping arrangement for line switches both without and with slip between shelves. The type of cable form required between shelves in the latter case is also shown.

In the more recent installations, line finders have been used instead of line switches. The line finder performs in a different manner the same function as the line switch.

Line Finders

In line finder installations, the subscriber's line is connected to a multiple bank instead of to a moving contact which hunts over a multiple bank, as is the case with line switches. These

distance from the office frames to the M.D.F. is considerable, the office frame multiple and the local incoming selectors are also cabled to the district multiple cross-connecting frame. Cross-connecting the two at this point instead of at the M.D.F. reduces the amount of cabling to the main frame.

The office frame multiple is slipped in exactly the same way as the district multiple. Both ends of each multiple bank are wired to terminal strips at either end of the frame so that any rearrangement that may be required for traffic reasons can be made.

Incoming Frames

The incoming frame multiple differs from that of other frames. Each multiple bank has a capacity for 100 terminals, and is divided into four equal layers with an overflow terminal at the top of each layer. The multiple within each of these four layers is slipped in accordance with drawing #706-125. This arrangement of the multiple provides 24 trunks and one overflow trunk which are used to reach a certain group of 500 lines on the final frames. Twenty-four trunks are usually insufficient to handle the simultaneous calls to a group of 500 lines; so in order to provide a sufficient number of these paths from the incoming frames to the finals, each group of 24 incoming frame multiple terminals is sub-grouped. Each sub-group is cabled separately to final selectors and the total number of terminals made available for paths to the final frames is equal to 24 times the number of sub-groups.

As a rearrangement of the incoming frame multiple will not be required frequently, no terminal strips are provided on the in-

coming frames, and the multiple is wired directly to selectors on the final frames.

The incoming selectors are wired to the main distributing frame where they are cross-connected to incoming trunks. These trunks may be either from manual or mechanical offices, or the incoming selectors may be cross-connected at this point to district or office frame multiple, and used as local trunks.

Final Frames

Since each terminal on the final frame represents a subscriber's line, the multiple is not slipped nor are overflow terminals provided as is the case with the other frames. The final multiple is cabled to the HIDEF for cross-connection to the tip, ring and sleeve of the line switch or line finder circuit. The tip and ring are cabled from the HIDEF to the HMDF for cross-connection to a cable pair.

The number of final selectors provided for each group of 500 subscribers' lines depends on the number of simultaneous connections that will be made to these 500 lines. This has already been mentioned in the discussion of the sub-grouping of the incoming frame multiple. In case the number of selectors required for 500 lines is more than 60, which is the capacity of a final frame, additional selectors are provided by multiplying together two or more frames. In case a whole frame is not required, a split final frame in which the multiple is divided in the middle may be used, and additional selector equipment for groups of 500 lines provided by multiplying the halves to different groups, according to the selector requirements.

Subscriber's Sender Selectors:

Sender selector switches are installed in shelves of 20 switches on a frame which normally contains 12 shelves, or 240 switches. The 22 sets of terminals on each switch are multiplied through the terminals of all the other switches on the same shelf. Since the set of contact brushes on the sender selector switch is of the "stay put" type, that is, it remains on the terminals of the sender with which it was last connected, the contact brushes will distribute themselves over the terminals in a random manner. The terminals are therefore wired straight through, except that between the tenth and eleventh switches the order is reversed.

Twenty-two senders will handle calls for considerably more than that number of district selectors, and to provide a proper load, several shelves of sender selector switches are multiplied together. If these shelves are to be served by less than 22 senders, terminals to which no sender is connected, are made to test busy, so that the contact brushes testing these terminals will advance to the next. Shelves of sender selectors thus wired together have a slipping arrangement between shelves, instead of being wired straight. The method of slipping is shown on the accompanying sketch "B". This method of slipping is adopted on account of the fact that it allows the same type of cable form to be used in multiplying all shelves together, regardless to the number of shelves per group. The cable from the senders is terminated on the middle shelf of the group shown on the sketch as Shelf #1, and the local cables extend in both directions from this shelf. The type of cable form required is also shown.

Each set of sender selector contact brushes is wired directly to a district selector. The sender selectors are therefore equal in number to the district selectors (excluding manual district selectors).

It has already been pointed out that the different classes of lines are grouped separately. This grouping must, of course, be carried to the sender selectors and senders, and only one kind of sender multiplied before a group of sender selectors.

Subscribers' Senders - 3 Digit

The three digit subscribers' senders are wired in groups of 22 or less to the multiple banks of the sender selectors, one group of senders being multiplied through several shelves of 20 sender selectors. As the different classes of service, such as message rate, coin box, flat rate, etc., require different operating features, separate groups of senders for each of these classes of lines must be provided. The senders are mounted on frames which have a capacity for five senders each.

Cabled to each three digit sender is one translator selector. This selector is mounted on a panel type frame which has ten multiple banks of 40 terminals each. The function of the translator is to route the call to the proper office as indicated by the first three digits the subscriber dials. The translator frame multiple banks are wired to a cross-connecting rack for cross-connection to the pulse leads from a pulse machine.

If translators for a group of senders were all mounted on the same translator frame, failure of this frame would put the entire group of senders out of commission. To prevent such an occurrence, translator frames are provided in sets of twos and the translator selectors of each group of senders are divided between the two translator frames. With this arrangement, the failure of a translator frame has no other effect than to cut down the number of working senders in the group. The pulse machines are provided with duplicate drums, one drum leading to each of a pair of translator frames.

Subscribers' Senders - 2 Digit

Two digit senders are mounted on frames which have capacity for 10 senders. The senders are wired in groups of 22 or less to the multiple banks of sender selectors in the same manner as the three digit senders. The grouping of these senders to serve different classes of lines is also accomplished in the same manner as that of the 3 digit senders.

Each translator is mounted on the frame with its sender. The two digit translator consists of two power driven rotary switches mounted side by side. The brushes are mounted on the same shaft, are single ended, and are set 180° apart, so that while the brushes of one switch are wiping over its multiple terminals, the brushes of the other switch are not in contact with any terminals. The setting of the brushes is governed by the first two digits dialed, and the circuit condition placed on the multiple bank terminals by the brushes, controls the selection of the proper trunk. The multiple bank terminals, class leads, and counting relay leads, are brought out to a common terminal strip at the side of the rotary

switch, where they may be cross-connected as desired.

Switching Apparatus for the 'A' Board

The 'A' board which is used in completing toll calls and to handle other calls requiring an operator, has been described in Section V-C. The semi-mechanical positions are arranged to complete calls mechanically and for this purpose requires district frames and senders in addition to the position equipment.

The manual district frames are similar to the regular district frames except that the multiple is laid out differently to accommodate trunks to toll points. The method of laying out the multiple is exactly the same as that used in laying out the subscriber's district frame multiple, that is, the slip, overflow terminals, etc., are provided in the standard manner. The manual district frame multiple is usually cabled direct to the main frame or may be, if desired, arranged so that any portion of it may be common to both the manual and subscriber's district frames.

In order that the semi-mechanical operators may have access to all the outgoing trunks in the office, a group of trunks known as operator's local district trunks are provided. These appear in the multiple of the manual district frames and this multiple is cross-connected to selectors on the subscribers' district frames.

Each selector on the manual district frames terminates in a single ended cord at the 'A' position. A semi-mechanical 'A' position has a capacity for 20 of these single ended cords and a selector frame for sixty selectors, consequently a manual district frame is required for each three semi-mechanical 'A' positions.

A special group of senders is required for the 'A' operators. A sender is associated with the cord over which a connection is being made by a stepper switch sender selector and cord-finder circuit known as a "link" circuit. Each 'A' position has a capacity for four of these link circuits. These link circuits are mounted on frames which will accommodate twelve link circuits per frame. One unit of this frame is therefore required for each three positions or for each manual district frame. The manual district frame and the sender selector frame which carry apparatus for the same three positions are installed as closely together as possible. The 'A' position senders are also mounted on the link circuit frames, each of which has a capacity for six senders in addition to the twelve link circuits.

The senders are wired to the link sender selector stepper switches in groups of 22 senders similar to the wiring of the subscriber's senders. When the total number of senders is less than 22, the spare trunks on the sender selector stepper switches are made busy. When the total number of senders is more than 22, they are divided into three or more groups; one group which is common to all positions and the remaining groups common to only part of the positions.

The checking multiple (described in Section V-C) is cabled from multiple lugs in the 'A' board to the HIDE where it bridges to the line circuit. One wire per subscriber's line is required for this purpose.

Switching Apparatus Required for 'B' Board

The 'B' board which is used to complete incoming calls from manual offices is described in Section V-A. For this purpose, incom-

ing frames and senders are required in addition to the position equipment and coil racks.

The incoming frames are similar to those already described, one selector being required for each connecting unit on the 'B' board.

A special group of senders, used as a common group by all of the positions, is required for the 'B' board. A sender is associated with a trunk by means of a trunk finder and sender selector circuit or link circuit of the panel type. The multiple over which these link circuits hunt consists of two banks of 100 multiple terminals each. These banks are split vertically in such a manner that one half of the multiple can be used for terminating senders, while the other half is used for terminating trunks with which the senders are to be associated. Each of these halves accommodates 18 selectors (9 on a side), which makes the capacity of a frame 18 link circuits. As six link circuits per 'B' position are sufficient, these 18 link circuits are arranged to serve three positions by dividing the trunk finding multiple into three equal parts, each part accommodating six selectors (3 on a side). The sixty or less connecting units of each position are wired to one of these multiple banks, and the remaining 40 sets of terminals in a bank, wired to the 20 adjacent trunks on either side of the 'B' position, to provide an overlap arrangement for team work. As the trunk finder multiple requires 5 wires per trunk and the sender multiple 4 wires per trunk, two multiple banks are necessary. The multiple of senders is slipped between the various frames in a manner similar to the slipping of a district of office frame multiple.

DESIGNATIONS

Line Switches

Line switch frames are numbered consecutively, each frame having its number on the top of the ladder guard rail on both sides thus -

LS-2

The switches on each frame are numbered consecutively from 0-179, as already explained. These numbers appear at the top of the switch frame on the motor unit side, and also on the lower part of the framework on the opposite side. The number of the subscriber's line associated with a line switch is displayed in a small designation strip attached to that switch immediately below the number on the motor unit side.

Since each line switch multiple bank is slipped, some means must be provided for determining what district selector any line switch has picked, by the position of the index wheel. When there is no slip between shelves of line switches in the same group, this is accomplished in the following manner: A card about five inches square is attached to a cable pin opposite the top shelf of a group. On this card is printed a table whose left hand column shows index wheel numbers and the remaining columns the numbers of the district selectors associated with the various line switches on that shelf. The numbers of the line switches appear as headings across the top of the table. By determining the number of the line switch and the number at which the indicator is stopped, the district selector to which it is connected can be read directly. When there is a slip arrangement between shelves of line switches, a master card somewhat similar to

that just described, is provided. This card carries a table which shows the number of the terminal on the terminal strip to which a line switch is connected in any given position of the index wheel. When this terminal number has been determined, the district selector to which the line switch is connected can be read from a vertical designation strip mounted at the end of each line switch shelf. The headings of this designation strip are -

Term. Strip <u>No.</u>	Dist. Sel. <u>No.</u>	Dist. Frame <u>No.</u>
------------------------------	-----------------------------	------------------------------

The 20 district selectors associated with a group of line switches are cabled to the line switches in two sets of 10 selectors. These sets of 10 selectors are cabled to opposite ends of the same line switch shelf. When there is no slip between shelves, the lettering on the terminal strip on which these cables are terminated, is as follows:

20		19
EVEN		ODD
D-1	or	D-2
2		1

When there is a slip arrangement between line switch shelves, each terminal strip displays, in addition to the above lettering, a reference number from which, by consulting a schematic drawing, the arrangement of the district selectors with respect to the shelf on which the district selector cables are terminated can be determined, thus -

20		19
EVEN	or	ODD
D-1		D-2
3		9
2		1

With the master card and designation strip scheme outlined above, it will not be necessary for the maintenance forces to consult this number for any purpose. The object of placing it on the terminal strip is for reference in case of rearrangement of equipment and in making up designation strips.

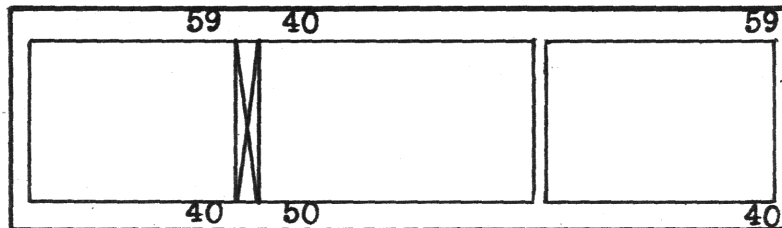
Line Finders

Line finder frames are numbered consecutively from #1 up, and the number is placed on the side of the frame about 5'9" from the floor, thus, -

LF - 1

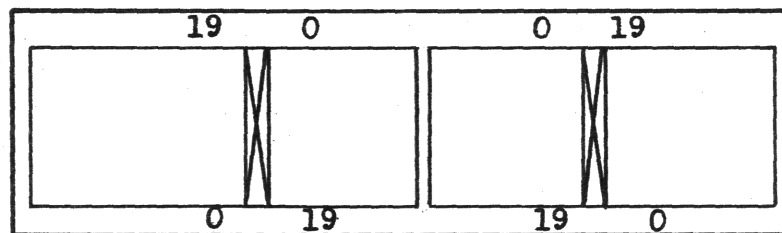
The multiple banks are numbered from 0-14, commencing with the bottom bank. These numbers are placed on the channel iron at the left of the bank. The reversal of the multiple of a group of line finder terminals is indicated by the numbers of the multiple bank terminals which are painted on the iron work which clamps the strips of the multiple bank together. These numbers appear on either side of the turn-over of the multiple, or at one end of the multiple in cases where the turn-over is made in the local cable between two frames. The standard manner of numbering various types of multiple banks is shown below, -

Cable to
line
relays



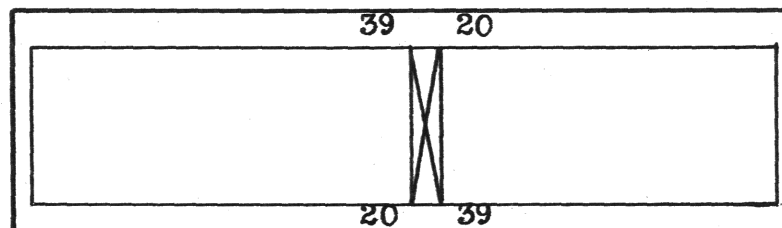
When cable to line re-
lays of this group ter-
minates on this frame
numbering is as shown.
If cable terminates on
adjacent frame, number-
ing is reversed.

Cable to
line
relays



Cable to
line
relays

Cable to
line
relays



Selectors on the line finder frames are number in the usual manner - odd numbers on one side and even on the other. They also have additional numbering which indicates what group of 300 subscriber's lines they serve, whether the multiple banks which they reach are reversed or straight, and to what district selector they are connected. All this numbering is placed on the clutch rail and has the following appearance, -

1- - - - 9 11 - - - - 19 21 - - - - 29 31 - - - - 39 41 - - - - 59
 ← G1-A → ← G1-B → ← G2-A →
 51 ← D-1 → 59 1 ← D-2 → 19 1 ← D-3 → 29

In the above sketch, the characters G-1 and G-2 refer to the group numbers of the 300 sets of multiple bank terminals. The letters

A and B are used to designate respectively the selectors which reach multiple banks which are straight or reversed. The characters D-1 and D-2 and the associated numbers indicate the district frames and the selectors on those frames, to which the line finders are connected.

One line relay rack is associated with each group of 300 line finder terminals. These relay racks are numbered consecutively with numbers which correspond to the group number of the 300 line finder terminals with which they are associated, the characters appearing on one of the uprights, thus -

LR - 1

On the other upright and opposite to the above, is shown the group number, thus -

G-1

The 20 sets of relays associated with a bank of 20 line finder terminals are numbered to correspond to the numbering of the multiple banks with which they are associated. The relay covers are numbered 0-19, 20-39, etc., to correspond to the number of the terminals.

No provision is made on line finder frames for determining directly a subscriber's line number from the number of a line finder terminal. Record must, therefore, be kept in such a manner that when the line finder group and terminal number are known, the subscriber's line number can be readily ascertained.

District Selectors:

District selector frames are numbered consecutively, the numbers appearing on the side of the frame, on a level with the center

When line finders are used, the same scheme is followed, except that the number of the selector on the line finder frame is also shown, thus -

1 3 5 7 9 11 13 15 17 19
21 ← ——— LF-1 ——— → 39

The district frames associated with the "A" positions are given a separate set of numbers. The numbering, which is located in the same relative position as on the regular district frames, has the following appearance.

A
POS
D-1

The method of designating the equipment to which any terminal is connected is, of course, the same as that used for the regular district frames. The numbers of the selectors and the numbers of the "A" positions and cords with which they are associated, are placed on the guard rail and have the following appearance:

(FRONT)

1 2 3 4 5 6 7 8 9 10 11 12 etc. - - - - 20 21 22 23 etc. - - - - 30
1 ← ——— A1 ——— → 20 1 ← ——— A2 ——— → 10

(REAR)

31 32 33 34 35 36 37 38 39 40 41 etc. - - - - - 60
11 ← ——— A2 ——— → 20 1 ← ——— A3 ——— → 20

It should be noted that on the "A" position district frames, the selectors are numbered consecutively, instead of odd numbers on one side and even numbers on the other.

or in the case of incoming selectors from full mechanical offices,

FM 2-W

Vertical designation strips similar to those used on the district and office frames, are placed at the end of each multiple bank on the incoming frame. These designation strips show the number of the final selector and frame to which the multiple terminals are connected.

Final Selectors:

Final frames are numbered consecutively in the following manner:

F-10
4500
to
4999

The selectors are numbered in the usual manner and have also the following designation:

1 3 5 7 9 - - - - - 59
←----- G2A ----->----- G2B ----->

The number 2 refers to the number of the choice and the letter to the sub-group of the incoming multiple in that choice.

No multiple bank designation strips are provided on final frames. The number of a line on which a selector rests can be readily determined by noting the brush which is tripped and the rack reading.

Subscribers' Sender Selectors

The subscribers' sender selector frames are numbered consecutively, commencing with #1. The number is placed on one of the uprights about 5-1/2' from the floor, and has the following appearance:-

The rotary switches, which are mounted in shelves of twenty, are numbered horizontally from 1 to 60 to correspond to the district selector to which they are connected. These numbers appear at the top of each switch on the motor unit side.

The number of the district frame with which a shelf of switches is associated is shown on the frame work at one end of each shelf, thus -

D - 12

On the same side of the frame, but at the opposite end of the shelf from this number, is a vertical designation strip which identifies any position of the index wheel of the switch with the sender to which it is connected. These strips have the following appearance:

Sender Selector Multiple Card		
Group No. _____		
Frame No. _____		
Shelf No. _____		
	Indicator Pos.	
Sender	Left	Right

Actual width about 1"

On account of the fact that the multiple bank is reversed between the 10th and 11th switches on a shelf, the sender to which a switch is connected will be indicated by one index wheel number for switches 1 to 10, and by another number for switches 11 to 20. This accounts for the presence of the columns headed "Right" and "Left" on the designation strip. As the shelves are slipped with respect to each other, the designation strips will be different for different shelves.

Between two designation strips near the middle of a group of sender selector shelves which are wired together, appears the number of the sender group to which these switches are wired, thus -

G-1

Arrows extend up and down from this lettering to include all the shelves of the group. The cables from the senders are terminated on terminal strips on one side of a sender selector shelf only. These terminal strips are lettered to show the sender group with which they are associated, and in addition carry a group reference number which indicates the arrangement of the senders terminating on that strip, with respect to the order in which they are terminated on the strip to which the sender cable is wired. By using this reference number and consulting a schematic drawing, the arrangement can be determined. Inasmuch as the senders associated with any sender selectors are shown on the designation strips, this reference number need not be used by the maintenance forces, and is displayed in the terminal strip only for record in case of equipment rearrangements, or making up the designation strips.

Senders

Subscribers' three digit sender frames are numbered consecutively, the numbers appearing on the front and rear ladder guards, thus -

DS- 2

The five senders on a frame are designated by the letters A to E. These letters are placed on the framework on the center line of each group of one kind of apparatus associated with a sender. The sequence switches of each sender are grouped vertically, and have, in addition

to the sender designation just described, the following additional markings:

SEND	Indicating Sender (switch)
S. & T. CONT	Indicating sender and translator control (switch)
COMP	Indicating compensating resistance (switch)
ROUTE	Indicating route (switch)
CLASS	Indicating class (switch)
RCI IMP	Indicating relay call indicator impulse (switch)

Subscribers' two digit sender frames and senders are designated in substantially the same manner as that just described. The ten senders on a frame are assigned letters from A to K, omitting the letter I.

The "A" position sender and sender selector frames which have capacity for 6 senders and 12 sender selector and cord finder circuits, are numbered consecutively, thus -

FR-1

As each "A" position is arranged for a capacity of four of these sender selector and cord finder circuits, each of these frames will mount this type of equipment for three positions. The frame number is, therefore, supplemented by the number of the "A" position with which apparatus mounted on that frame is associated. These position numbers are placed at the top of the bay in which the corresponding apparatus appears, thus -

A-1

The senders which are wired in common groups, and not associated with any one "A" position, are designated by the letters A to F, which letters, like those of the subscribers' senders, appear on the center line of each group of one kind of apparatus associated with that sender. The sequence switches and other kinds of apparatus in any group included within these letter designations, are also identified by abbreviations placed on the framework opposite the apparatus to which they refer. They are:-

SS	Indicating sender selector
CDF	Indicating Cord Finder
RS1 or RS2	Indicating Route Switch
KC	Indicating Key Control
REG CONT	Indicating Register Control
SEND	Indicating sender
SEND CONT	Indicating sender control
ALL	Indicating alloter
ROUTE	Indicating route
IND	Indicating call indicator impulse
CLASS	Indicating class

The sender selector and cord finders are of the rotary switch type i.e., senders are multiplied on the bank of a rotary switch at one end of the circuit and the cords of the position on the bank at the other end of the circuit. In order to identify the sender or cord a switch has picked from the reading of the index wheel, vertical designation strips, showing the sender or cord corresponding to each

position of the index wheel, are placed at one end of the multiple banks. For the sender selector switches, these designation strips have the following appearance: -

A SWBD SENDER SELECTOR MULTIPLE CARD FRAME NO. _____ POS. NO. _____		
Sender Frame No.	Sender No.	Ind. Pos.

Actual width about 1".

The cord finder designation strips have the same appearance with the exception that the headings are changed to read "Cord No." instead of "Sender No."

The "B" position sender and sender selector frame is of the panel type. It has a capacity for 18 trunk finders and sender selectors, and 6 senders. The multiple banks and selectors are similar in construction to those of a district or office frame. The multiple banks are divided vertically in such a way that one half is used for the trunk finders, and the other half for the senders. Vertical designation strips are mounted on the left hand side of a bank on each side of the frame, one designation strip indicating the layout of the sender multiple, and the other the multiple of the trunks. These designation strips have the following appearance:

manner similar to the numbering on district or office frames. In addition to this numbering, which appears on the clutch rail, there is also additional numbering to indicate the sender to which the selector is connected, thus -

1 3 5 7 9 11 13 15 17 19 - - - - - 59
 A B C D E A B C D E
 S-2 S-4

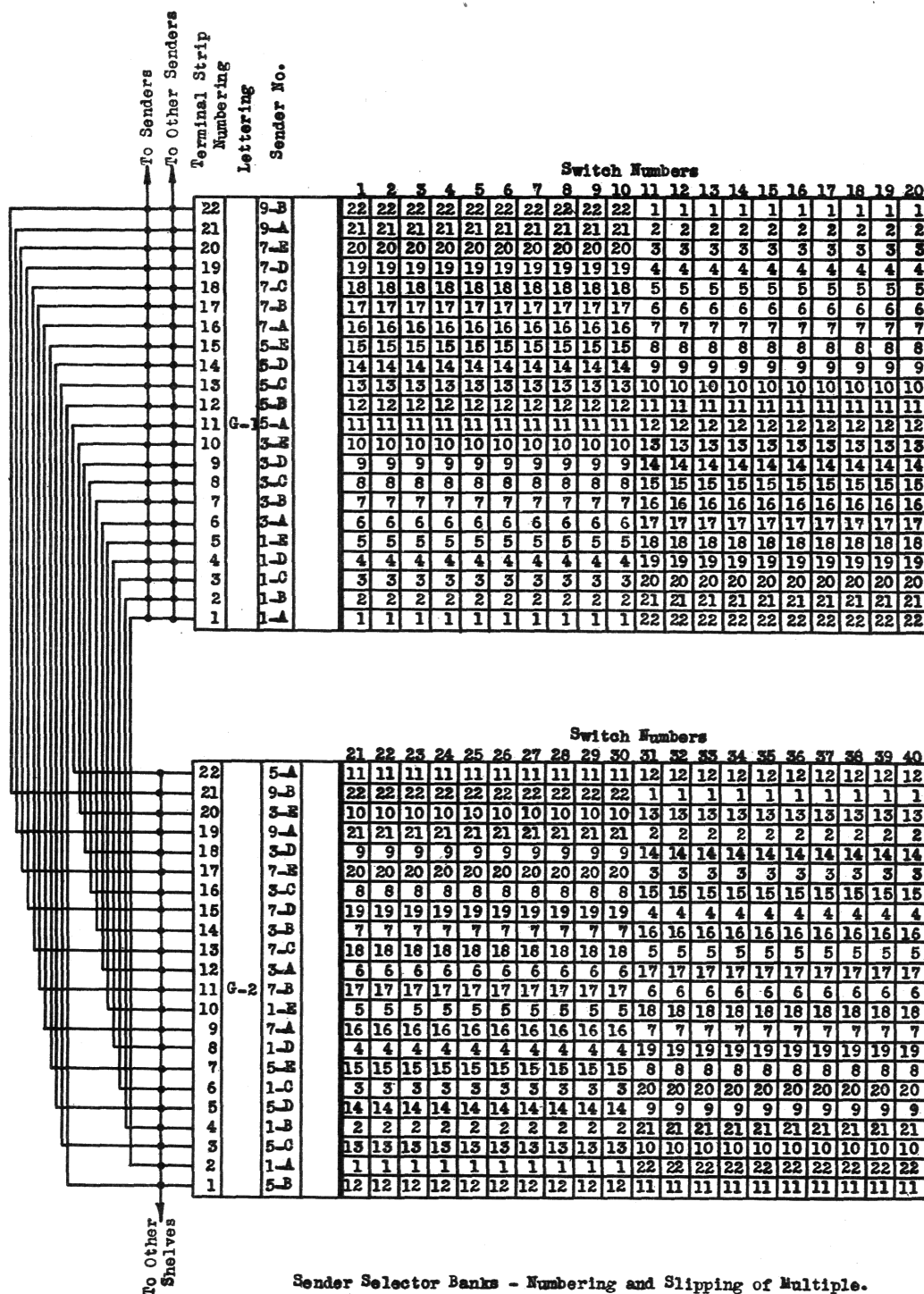
Each multiple bank is provided with a vertical designation strip which shows the office to which a call will be routed when the selector brush rests on any particular terminal. This designation strip has the following appearance: -

Translator	
Bank	
Rack	Office
39	
38	
37	
2	
1	
0	
Frame	

Actual width about
 1-1/4 inches.

Corresponding multiple bank terminals of a pair of frames are wired through resistance lamps, which are common to the two frames. These lamps, one of which is required for each tip, ring, and sleeve, are mounted 10 per strip between the two translator frames which they serve. The multiple bank with which they are associated is indicated by a number plate at the left of each group of 40 sets of lamps. Each strip of 10 lamps is also provided with a designation strip for indicating the terminal number and the part of the circuit (tip, ring or sleeve) with which it is associated.





Sender Selector Banks - Numbering and Slipping of Multiple.

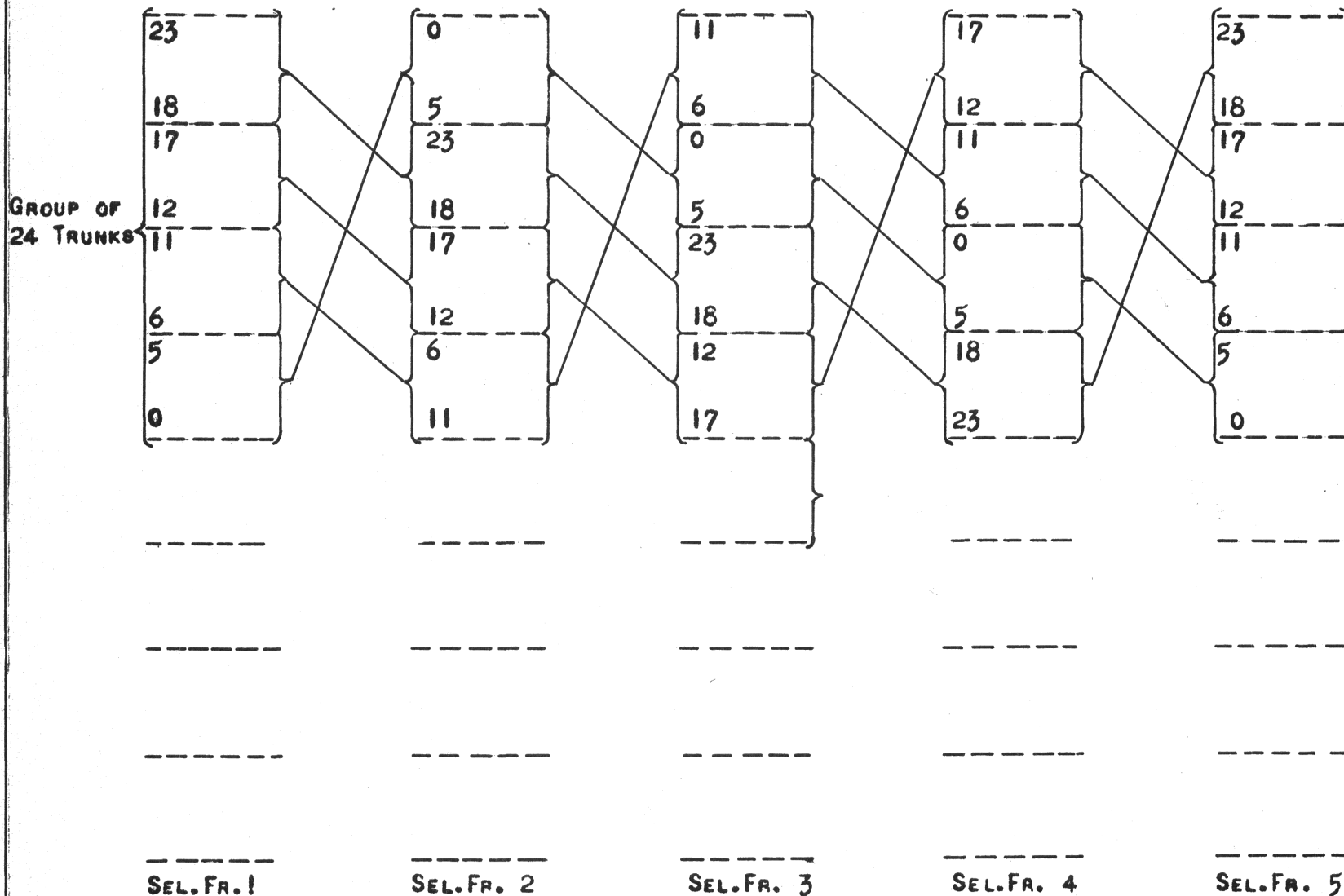
NOTE A: Numbers within squares represent circuits; for example, number 15 represents circuit to sender 5-E.

NOTE B: Index wheel reading in any position corresponds with terminal strip numbering shown above.

SKETCH B

MULTIPLE ARRANGEMENT OF INCOMING SELECTOR FRAMES

ISSUE 1.

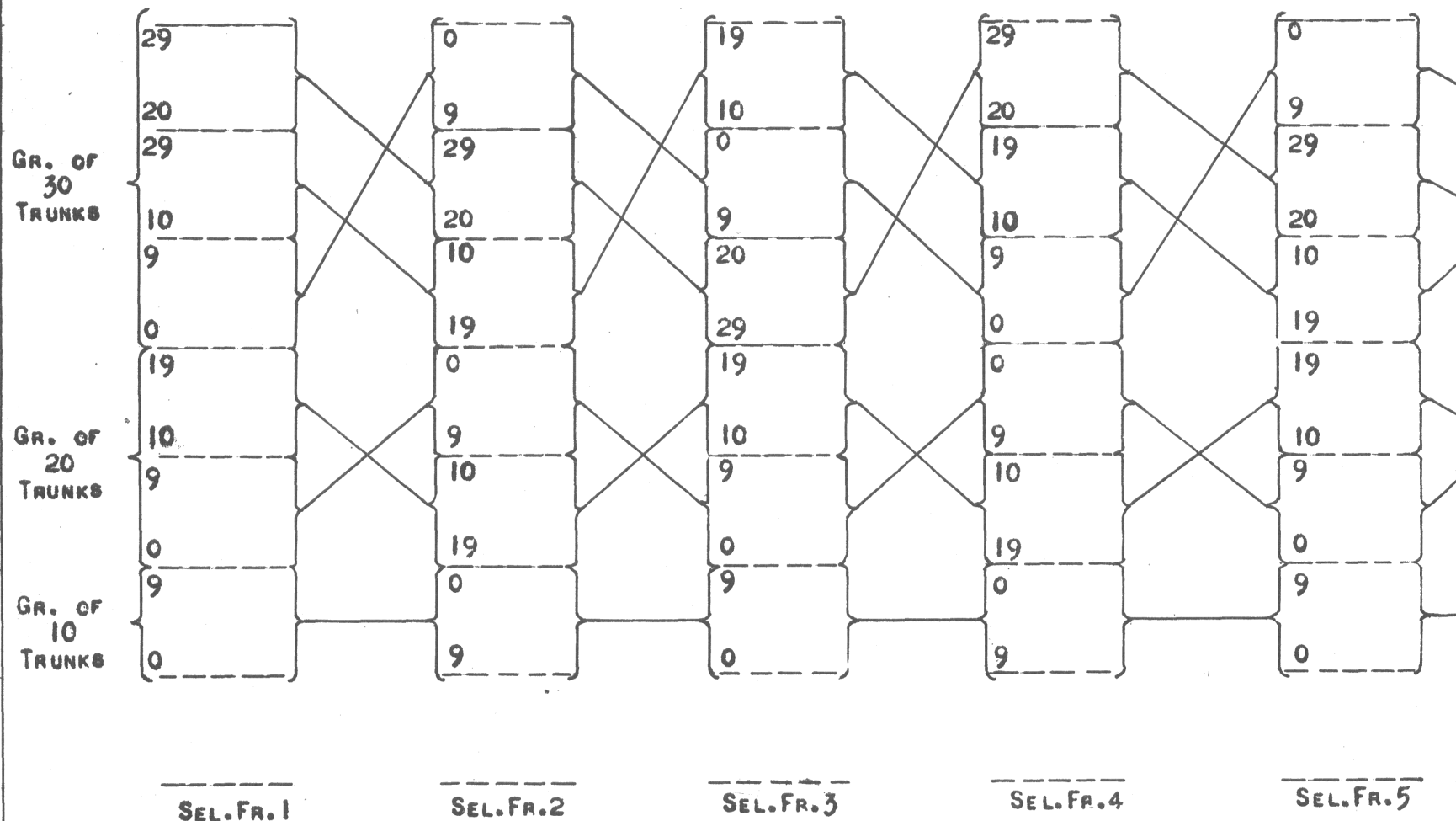


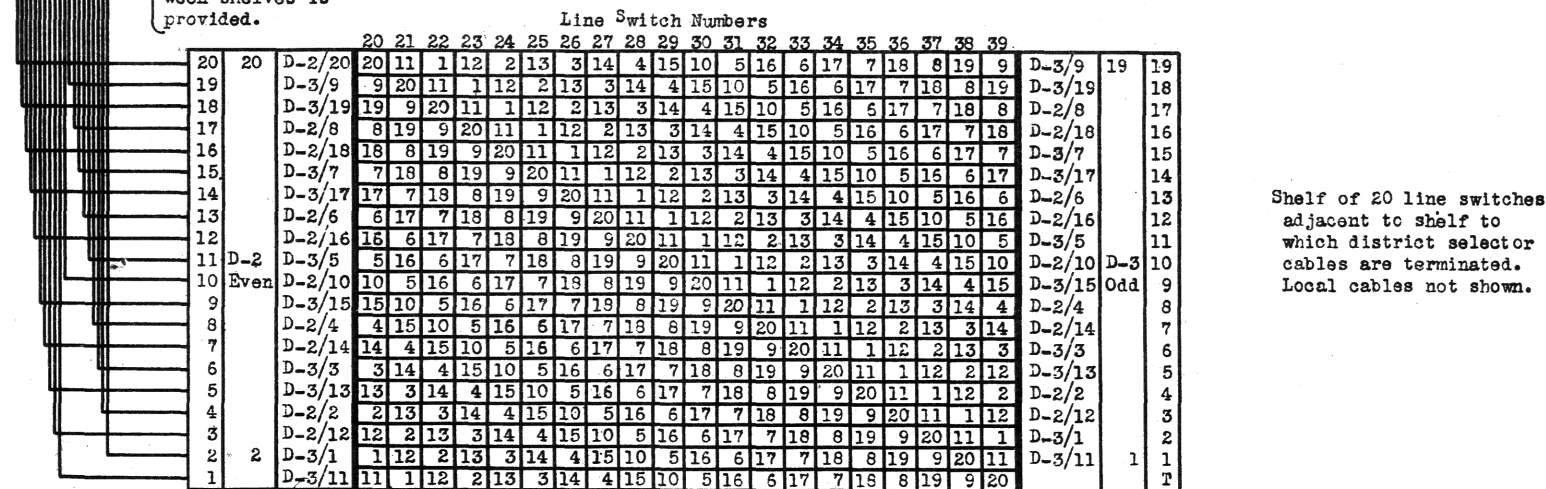
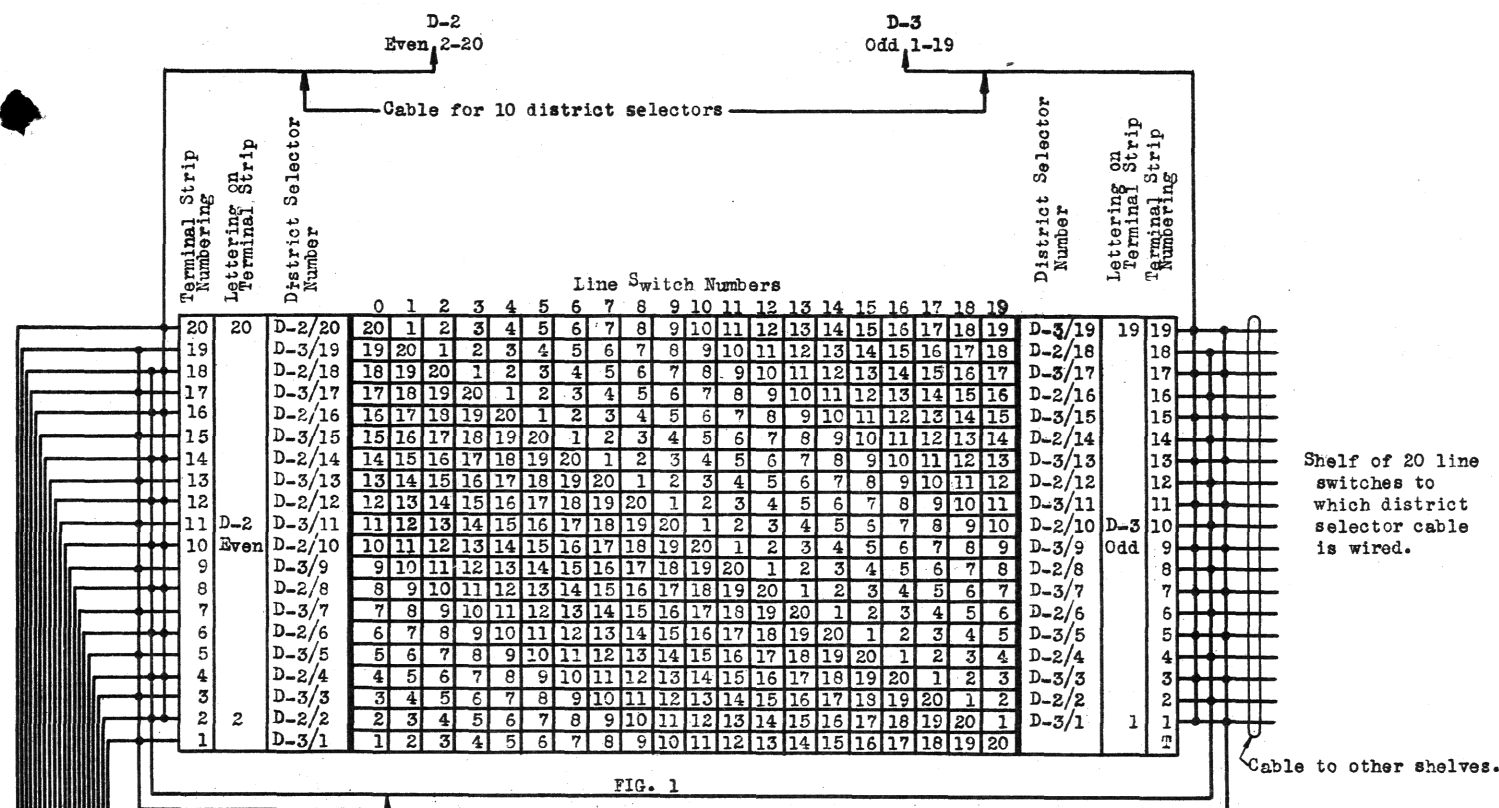
METHOD OF SLIPPING O.G.T. MULTIPLE ON DISTRICT
AND OFFICE SELECTOR FRAMES

ENGINEER
DRAFTSMAN
CHECKED BY *MFR*

Log No. P-66,913-18

ISSUE 1.





Line Switch Multiple Banks - Numbering and Slipping of Multiple.
 When there is no slip between shelves, all shelves are like Fig. 1.
 When there is slip between shelves, shelf below will be arranged as shown in Fig. 2. Other shelves will have different arrangements, which are obtained by using local cable form shown.

SKETCH A.

FULL MECHANICAL SYSTEMALARMS AND SIGNALS

The arrangement of the alarms in machine switching offices is substantially as follows:-

Main Alarm Board - Located near the trouble desk. Contains alarm lamps for apparatus on same floor as trouble desk. It is provided also with a master pilot for each class of alarms for apparatus on other floors.

In offices for which the engineering work has not been completed it is planned to place the master pilots in the trouble desk so that the main alarm board will become simply a floor alarm board for the trouble desk floor.

Floor Alarm Board - One on each floor other than that on which the trouble desk is located. Contains alarm lamps for apparatus on the same floor.

Power Alarm Board - Located near the power plant. Contains alarm lamps for the power equipment.

Each alarm board is provided with two auxiliary alarm bells, one a direct current vibrating bell for the more important alarms, and the other an alternating current bell for all other alarms. The audible A.C. signal for master pilots mounted in the trouble desk will be a buzzer.

The alarm system, in general, is laid out with the

trouble desk as the center of operations.

Following is a description of the various alarms and the action to be taken in each case.

FUSE ALARMS

CHARGING FUSES OPEN OR BLOWN See ES-226102

Lamp signal and A.C. bell on power plant floor.

Lamp signal and A.C. bell at main alarm board or lamp signal and buzzer at trouble desk.

Action to be Taken

If the circuit breaker is tripped on any charging machine which is in operation, shut down this machine and open the generator switch.

Test leads between the circuit breaker and blown fuse with a head receiver. If leads do not test clear of battery and ground, the cross shall be cleared immediately.

Place a new fuse.

If the circuit breaker failed to operate when the fuse was blown, increase the generator out-put to the value shown on or near the circuit breaker. The circuit breaker should operate. If the circuit breaker needs any adjustment or repairs, these shall be made as soon as possible by the regular machine man.

DISCHARGE FUSE OPEN OR BLOWN See ES-226102

Lamp signal and D.C. bell on power plant floor.

Lamp signal and D.C. bell at the main alarm board or trouble desk.

If the fuse is for apparatus on a floor other than that on which the trouble desk is located, signals will also appear in the floor alarm board for that floor.

Action to be Taken

Short circuit blown fuse by means of the adjacent switch. This cuts in an emergency fuse.

If emergency fuse should blow, inspect the leads and bus bars between the fuse and associated distributing panel for cross or ground. If trouble is not located and cleared immediately the Wire Chief shall be notified.

Then proceed as follows:-

1. Remove the 1/2 ampere alarm type fuse for each N.E.C. fuse on the associated distributing panel.
2. Remove the N.E.C. fuses and place a new discharge fuse in service.

If this discharge fuse blows, the trouble shall be reported at once to the Power Plant Supervisor.

If the fuse holds, insert new N.E.C. fuses in place of those removed from the distributing panel. Replace the blown emergency discharge fuse. Replace the 1/2 ampere alarm type fuses.

As soon as the discharge circuit is maintained without blowing the fuse, the positions of any selectors affected shall be checked and those found off normal shall be restored in accordance

with instructions given under Method of Taking Apparatus Out of Service.

Any N.E.C. fuses removed should be inspected before placing them in stock.

DISTRIBUTING PANEL FUSE OPEN OR BLOWN See ES-226102

Lamp signal and D.C. bell at floor alarm board.

Lamp signal and D.C. bell at either the main alarm board or trouble desk.

Action to be Taken

Inspect individual fuse panels for ground or cross. If no trouble is found, remove individual fuses from the fuse panels.

Place new distributing panel fuse and associated 1/2 ampere alarm type fuse.

Replace the individual fuses one by one until either all of them have been replaced or the distributing fuse is blown again indicating the circuit in trouble.

All fuses removed or blown except that of the circuit in trouble shall be replaced.

The apparatus of the circuit in trouble shall be taken out of service in the regular way.

The positions of any selectors which may have been affected by the blown fuse shall be checked and those found off normal shall be restored to service in the regular way.

After trouble has been cleared, replace the fuse and

restore the apparatus to service.

SELECTOR FRAME FUSES OPEN OR BLOWN See ES-226102

Lamp signal on fuse panel.

Red aisle pilot.

Lamp signal and A.C. bell at floor alarm board.

Lamp signal and A.C. bell at main alarm board or
lamp signal and buzzer at trouble desk.

Action to be Taken

Replace blown fuse and see that any apparatus affected
is in normal position.

If fuse does not hold, the apparatus shall be taken out
of service and the trouble cleared, after which the fuse shall be
replaced and the apparatus restored to service.

INDIVIDUAL ALARM TYPE FUSES OPEN OR BLOWN See ES-226102

Miscellaneous	Coin
Repeat coil	Tone
Line relay	Clock
Ringling	

Lamp signal on fuse panel.

Lamp signal and A.C. bell at floor alarm board.

Lamp signal and A.C. bell at main alarm board or lamp
signal and buzzer at trouble desk.

Action to be Taken

Replace blown fuse and see that any apparatus affected
is in normal position.

If fuse does not hold, the apparatus shall be taken out of service and the trouble cleared, after which the fuse shall be replaced and the apparatus restored to service.

CIRCUIT BREAKER TRIPPED See ES-226102

Lamp signal and A.C. bell on power plant floor.

Lamp signal and A.C. bell at main alarm board or lamp signal and buzzer at trouble desk.

Action to be Taken

Determine which generator has a circuit breaker tripped with charging switch closed.

Open the charging switch.

Ascertain whether the generator was running for charging or floating the battery with which it was connected. Re-establish this condition in the regular manner unless the charge has been completed, in which case the battery shall be floated or the charging unit shut down in accordance with established routine.

PHASE FAILURE See ES-226102

The phase failure alarm is used to indicate the failure of any one of the outside A.C. power leads, as the effect on the driving motors of the failure of a single lead would not be noticed immediately. The failure of an A.C. lead causes the phase failure device to open the circuit of the P.F. relay which in turn causes the following alarms to be given:-

Lamp signal and D.C. bell on power plant floor.

Lamp signal and D.C. bell at main alarm board or trouble desk.

Action to be Taken

Operate key at power alarm cabinet and notify Power Co. at once. The operation of this key lights the phase failure guard lamp at power alarm cabinet, cuts off the alarm circuits, and switches them so that they will operate as soon as the phase is restored. When this occurs, restore the key to normal in order to cut off the alarms and put out the guard lamp.

VOLTAGE ALARM - 48-VOLT BATTERY See ES-226102

This alarm indicates that the voltage of the 48-volt discharge leads is below 45 or above 50 volts.

Lamp signal for each floor (designated LV) and A.C. bell in power alarm cabinet.

Lamp signal for each floor (designated HV) and A.C. bell in power alarm cabinet.

Lamp signal for each floor and A.C. bell at main alarm board or lamp signal and buzzer at trouble desk.

Machine switching offices will be provided with four battery sets of twelve cells each, designated #1A, #2A, #1B and #2B respectively. They are arranged so as to form two 48-volt batteries i.e. #1A and #2A are connected in series permanently as are also #1B and #2B.

Either 48-volt battery can be used alone or both of them in parallel to carry the load. 24-volt current is obtained from either #1A or #1B battery. Any one of the four batteries can be placed under charge separately. Batteries which are being floated may be placed in service but batteries under charge shall not

be placed in service. The high voltage alarm should operate, therefore, only when batteries in service are being floated and a rise in voltage occurs on account of reduced load.

The operation of the low voltage alarm is an indication that one or both of the batteries in service may need charging or that one or more cells may be in trouble.

In addition to the regular batteries, there are four emergency cells so arranged that in cases of emergency one of them can be cut in series with the 24-volt discharge lead to raise the voltage, and one or more of the other three can be cut in series with the 48-volt discharge lead. These cells are given a continuous trickle charge from one of the 24-volt batteries. See Section VII.

Action to be Taken

Ascertain which batteries are in service.

High Voltage Alarm - Reduce the output of the generators which are floating the batteries in service until battery ammeters show slight discharge readings. This should retire the alarm. If unnecessary to continue floating the batteries disconnect the charging generators from the batteries and shut down the machines in the regular way.

Low Voltage Alarm - Determine the cause of the alarm and take the necessary action to raise the voltage of the discharge leads to the proper point, being governed by instructions in Section VII. It may be necessary to:-

Transfer the load to the other batteries and place under charge the batteries removed from service.

Cut in one or more of the emergency cells.

In case of trouble in one or more of the cells, notify the Power Plant Supervisor at once.

RINGING GENERATOR ALARMS See ES-226102

Failure of the ringing generator is indicated by:-

Lamp signal and D.C. bell on power plant floor.

Lamp signal and D.C. bell at main alarm board or trouble desk.

Action to be Taken

Start other ringing machine and throw the ringing transfer switches into the position corresponding to the machine being placed in service.

If alarm is still given, the open generator circuit thus indicated shall be traced with a head receiver and the trouble cleared as soon as possible.

If the alarm is retired by placing another machine in service, the trouble shall be referred to the regular machine man for attention.

MACHINE RINGING ALARM - SINGLE PARTY OFFICES See ES-226102

Failure of machine ringing current in single party offices is indicated by:-

Lamp signal and D.C. bell on power plant floor.

Lamp signal and D.C. bell at main alarm board or trouble desk.

Action to be Taken

Start other ringing machine and throw the ringing transfer switches into the position corresponding to the machine being placed in service.

If alarm is still given, the open circuit thus indicated shall be traced with a head receiver and the trouble cleared as soon as possible.

If the alarm is retired by placing another machine in service, the trouble shall be referred to the regular machine man for attention.

MACHINE RINGING ALARM - FOUR PARTY OFFICES See ES-226102

Failure of either the positive or negative superimposed ringing current in four party offices is indicated by:-

Lamp signal and D.C. bell on power plant floor.

Lamp signal for each polarity of ringing current, and D.C. bell at main alarm board or trouble desk.

Action to be Taken

Start other ringing machine and throw the ringing transfer switches into the position corresponding to the machine being placed in service.

If alarm is still given, the open circuit thus indicated shall be traced with a head receiver and the trouble cleared as soon as possible.

If the alarm is retired by placing another machine in service, the trouble shall be referred to the regular machine man for attention.

PULSE MACHINE FUSE ALARM See ES-226102 & 226573

Blown fuses on pulse leads or ground supply leads for pulse machine drums are indicated by:-

Lamp signal and D.C. bell on power plant floor.

Lamp signal and D.C. bell at main alarm board or lamp signal and buzzer at trouble desk.

Action to be Taken

Place new fuse.

If fuse does not hold, locate trouble as soon as possible and replace fuse.

A blown ground supply fuse may be due to a battery cross on the pulse machine itself in which case the load must be transferred immediately to another machine until the trouble is cleared.

In the case of a blown pulse lead fuse it will be necessary to depress and release the associated alarm restoring key in order to retire the alarm.

PULSE MACHINE BATTERY ALARM See ES-226102 and 226573

Crosses with battery on translator pulse machine leads are indicated by:-

Bank lamp flashing at translator frame.

There is one bank lamp for each terminal strip of each translator frame. A flashing bank signal indicates trouble which affects only the lead identified by the signal i.e. it does not affect other leads fed from the same pulse machine drum.

Lamp signal and D.C. bell on power plant floor.

Lamp signal and buzzer at trouble desk.

Action to be Taken

Depress and release the associated alarm restoring key at either the main alarm board or the power alarm cabinet. Should this restore the signals, no further action is necessary.

If the signals are not restored by the operation of the key, proceed as follows:-

1. Ascertain which bank lamp is flashing.
2. Inspect the translator bank multiple to ascertain whether a translator is connected to the lead indicated, and if so, reset the brush and note the number of the translator. If this restores the signals, take out of service the associated sender, clear trouble and restore sender to service.
3. If no translator is found attached or if the bank lamp is

not extinguished by resetting the multiple brush, inspect the multiple terminals of this lead for crosses. If trouble is found, clear it as soon as possible and restore the alarm by means of the alarm restoring key.

4. If the trouble is not found by this inspection, proceed to locate it in or out of the multiple bank. If the bank lamp is extinguished by opening the lead at the multiple bank, a cross in the multiple bank is indicated, in which case a critical inspection of the bank terminals shall be made in an effort to locate the cross. If the trouble can not be located in this manner, it will be necessary to change the multiple bank. This shall be done when traffic is light, and in accordance with instructions given under Section XVI.

Before changing the bank, the senders associated with the translators affected shall be taken out of service.

If the trouble is located outside the multiple bank, clear it as soon as possible.

Line Switch Alarm - See ES-226102 and 207866

The purpose of this circuit is to indicate a grounded line switch DS brush or lead. One circuit is common to the line switches on not more than five bays. A line switch with a grounded DS brush or lead will step around continuously instead of stopping on the first idle district circuit whenever the associated subscriber attempts to make a call.

Trouble of this nature will be indicated by:-

Lamp signal and A.C. bell at floor alarm board.

Lamp signal and A.C. bell at main alarm board or lamp signal and buzzer at trouble desk.

Action to be taken

Go to the group of line switches indicated by the alarm and locate the switch which is hunting continuously.

Release the line relay by tooth picking open the ring side back contact of cut-off relay. This will allow the line switch to return to normal.

Then block the line relay with a wedge so that it can not operate, and remove tooth pick from cut-off relay.

Restore the alarm by depressing and releasing the alarm release key at the floor alarm board.

Line switch trouble should be cleared at once. If the trouble is of such a nature as to require the replacement of the line switch, the tracer shall notify the desk switchman who will

order the line put up on a plugging-up line or else have the line temporarily cross-connected to a spare line switch.

After the trouble has been cleared the line shall be closed through and service restored by removing the wedge from the line relay.

Selector Time Alarm - See ES-226102 and 207019

The selector time alarm circuit will be used to indicate certain trouble conditions in which either district or final selectors are involved. The alarm will be given within a certain time interval after the trouble condition appears. The length of this interval has not been decided upon but will be adjusted to meet conditions. Circuit ES-207019 shows the wiring of the stepper for time intervals of 1/2, 1, 2, 3 and 4 minutes.

The signals given will be as follows:-

Lamp signal at selector frame.

White aisle pilot.

Lamp signal and A.C. bell at floor alarm board.

Lamp signal and A.C. bell at main alarm board or lamp signal and buzzer at trouble desk.

The following description of the circuit operations is given for a one minute time interval. See Fig. 1, ES-207019.

The selector circuit involved supplies ground to operate and lock up the PS relay which is common to all selectors on the same side of the frame. Battery for operating the PS relay is

supplied through a normal contact on the PU arc of the stepper.

Relay STP operates - front contact PS Ry.

Stepper advances to Pos. 4 - front contact STP Ry. and interrupter contacts (3 sec. make and 27 sec. break). The time for this operation varies from approximately one minute to 1-1/2 minutes depending upon the position of the interrupter when the STP relay operates.

In Pos. 4, S relay operates - circuit closed at PU arc of stepper.

STP Ry. releases - circuit opened by S Ry.

S Ry. locks up through other winding to ground at front contacts of PS Ry.

S Ry. closes the circuits for operating the alarm signals.

District Time Alarm

The selector time alarm in connection with district circuits operates during the time interval when any of the following conditions obtain:-

1. Sender selector fails to pick a sender or the district sequence switch for any other reason fails to move out of Pos. 2.
2. District sequence switch fails to move out of Pos. 17 following registration.
3. Calling subscriber fails to hang up after the called subscriber has hung up.

4. District sequence switch fails to move out of Pos. 1.
5. Party timing switch (two-party message rate district selector) fails to move out of Pos. 3 or 4.

Action to be taken

Go to the district frame indicated by the alarm and check positions of sequence switches off normal to see if any are in Pos. 2.

(a) District S. Sw. in Pos. 2 - Sender Found

If a sequence switch is found in Pos. 2 and the associated sender selector has found a sender:-

Insert a make busy plug in the MB jack of the selector and block the SL relay so that it will not release.

Open the top outer contact of T cam momentarily. This will release the subscriber's cut-off relay and allow line switch to hunt for another district.

Retire the alarm by insulating the bottom outer contact of O cam.

Locate and clear trouble.

Remove insulator from O cam and wedge from SL relay.

Restore selector to service.

(b) District S. Sw. in Pos. 2 - Sender Selector Hunting

If a sequence switch is found in Pos. 2 and the associated sender selector is hunting:-

Determine whether any senders in the group are available. If no senders are available, report this condition to the Desk Switchman.

If there are senders available, proceed as in (a).

(c) District S. Sw. in Pos. 17

If a district sequence switch is found in Pos. 17:-

Make the selector busy.

Block up SL Ry. so that it will not release.

Retire alarm by pushing down CH relay. This will also release subscriber's cut-off relay and allow line switch to return to normal.

Locate and clear trouble.

Restore selector to service.

(d) District S. Sw. in Pos. 12 or 13 - Calling Subs. failed to hang up

If no sequence switch is found in either Pos. 2 or Pos. 17:-

Look for a sequence switch in Pos. 12 or 13 with CH relay operated and CS relay down. These conditions will obtain if calling subscriber fails to hang up after called subscriber has hung up.

Move sequence switch by hand to Pos. 18. The brush rod will then return to normal and advance the sequence switch to normal.

This will release the line switch which will pick another district selector. As a result the trouble condition will be brought to the attention of the sender monitor as a permanent signal.

(e) District S. Sw. in Pos. 1

If none of the conditions given under (a), (b), (c) and (d) exists:-

Look for a sequence switch in Pos. 1 with drive plate

energized or with the associated CH and SL relays operated.

If one is found, make the circuit busy and release the line switch by opening T bottom outer contact momentarily.

Locate and clear trouble.

Restore selector to service.

(f) Party Timing Switch - (Two Party Message Rate District) in Pos. 3 or 4. - District S. Sw. in line finder office will be in Pos. 10. District S.Sw. in line switch office will be in Pos. 11. In addition to the selector time alarm, a stuck sender signal will be given at the sender monitor.

The selector time alarm when received as a result of the failure of the party test switch to move out of Pos. 3 or 4 is an indication of the failure of the T relay to function properly on the soak and release test which it receives prior to the party line test.

The district selector or district selector and line finder should be taken out of service in the regular way and the subscriber's line released as soon as possible.

A check test of the T relay should be made before restoring the apparatus to service.

Final Time Alarm

The selector time alarm in connection with final circuits operates during the time interval if called subscriber fails to hang up after calling subscriber has hung up.

Action to be taken

Go to the final frame indicated by the alarm and locate

the final sequence switch which is in Pos. 16.

This can be done easily as the index wheels will be marked with a red stripe in Pos. 16.

Move the sequence switch to Pos. 18 by hand. The brush rod will then return to normal and advance the sequence switch to normal.

This will release the line so that the line switch will pick a district selector and as a result the trouble condition will be brought to the attention of the sender monitor as a permanent signal.

Cordless Emergency Sender Alarm - See ES-226102 and ES-226345

Each cordless "B" position is provided with a key by means of which an alarm may be operated to notify the Desk Switchman that the position is out of service. When one of these keys is thrown, the following signals are given:-

Lamp signal at cordless "B" position.

Lamp signal and D.C. bell at main alarm board or trouble desk,

or

Lamp signal and D.C. bell at floor alarm board with class pilot and audible signal at trouble desk.

Action to be taken

Determine whether necessary to use the emergency key set and if so assist the Supervisor in substituting this set for the regular set at the position indicated by the lamp signal. In

this case the trouble with the regular equipment should be cleared as soon as possible and the regular equipment restored to service.

If the trouble is such that the use of the emergency key set will not restore the position to service, the apparatus causing the trouble shall be taken out of service and the trouble cleared as soon as possible.

If either key control circuit has to be taken out of service a key control circuit of like designation from an unoccupied position shall be substituted for it if possible.

Line Finder Time Alarm - See ES-226102, ES-226354 and ES-226379

The line finder time alarm circuit is arranged to give an alarm whenever a calling subscriber's line is not picked up by a line finder within a period of approximately 30 seconds after the removal of the receiver from the hook.

There is one time alarm circuit for each group of line finders serving 300 lines. When a subscriber makes a call, the line relay and the BA relay of the associated trip circuit are operated and remain operated until the line is picked up by a line finder, which results in the operation of the cut-off relay and the consequent release of the line and BA relays. This requires from .4 to .7 seconds.

The operation of the time alarm circuit is under the control of the BA relays of the 30 associated trip circuits and the time alarm interrupter. An operated BA relay connects battery through 1000 ohms to the B lead of the time alarm circuit for the

purpose of operating the B relay upon the closure of the interrupter. If a BA relay remains operated for a period of approximately 30 seconds, or battery is maintained on the B lead for the same length of time by the overlapping operation of a number of BA relays, the following alarm signals will be given:-

Lamp signal at relay rack, identifying the trip circuit involved.

White aisle pilot.

Lamp signal and A.C. bell at floor alarm board.

Lamp signal and A.C. bell at main alarm board

or

Lamp signal and buzzer at trouble desk.

The removal of the trouble condition will retire the alarm automatically.

Action to be taken

Go to the frame indicated by the alarm and ascertain what trouble condition is causing the alarm.

If all line finders in the group are not engaged see whether there are any "made busy" which can be restored to service and, if so, restore them at once. Otherwise, locate and clear the trouble as soon as possible.

If all line finders are engaged and the alarm is not retired within a reasonable length of time by the release of line finders which become available, report this condition to the Desk Switchman.

The alarm can be retired temporarily by depressing and releasing the associated alarm release key at the relay rack.

Line Finder Tell Tale Alarm - See ES-226373

Lamp signal at line finder frame.

White aisle pilot.

Lamp signal and A.C. bell at floor alarm board.

Lamp signal and A.C. bell at main alarm board

or

Lamp signal and buzzer at trouble desk.

Action to be taken

Insert a make busy plug in the M.B. jack of the line finder at tell-tale. This will restore the line finder to normal.

Locate and clear trouble before restoring line-finder to service.

Motor Stop Alarm - See ES-207248, 226102 and 226349

General

Associated with each drive motor is an alarm circuit controlled by a centrifugally operated contact assembly on the motor shaft. The contacts are so arranged that one of them is closed when the motor is at rest or running at reduced speed, and another when the motor is running at normal speed.

The stopping or slowing down of a drive motor is indicated by the following alarms:-

Red lamp signal and A.C. or D.C. bell at floor alarm board.

Red lamp signal and A.C. or D.C. bell at main alarm board

or

Red lamp signal and buzzer or D.C. bell at trouble desk.

Frame busy circuits also are operated in connection with the motor stop alarms for the following classes of frames:-

District (with line switches)

Line Finder

Sender

Action to be taken

Frame Drive Motor Failure

Operate the associated motor stop key to retire the alarm signals and light the motor stop guard signal (white).

Determine the cause of the motor failure and take the necessary steps to place the frame in service as soon as possible.

If the frame or frames can not be placed in service at once and are not provided with frame busy circuits, see that the units involved which are at normal are made busy individually. In the case of cordless trunk units, notify the Traffic Department Supervisor as to which units are out of service.

As soon as the frame is placed in service again see that any units removed from service on account of the motor failure are restored to service. In general, units on frames provided with

frame busy circuits will have the busy condition removed automatically when the motor is started. On district frames, however, which are provided with frame busy keys, it will be necessary to restore these keys if they have been operated for any reason in connection with the motor failure.

The starting of the motor will cause the alarm signals to be given again. At this time the white guard signal also is lighted. When both the red and the white signals are lighted at the same time, restore the motor stop alarm key in order to retire the signals and to place the alarm circuits in normal operating condition.

Pulse Machine Motor Failure

Start spare pulse machine and place in service at once. This will retire the alarm signals automatically.

Determine the cause of the motor failure and see that the machine is made available for use as soon as possible.

METHOD OF TAKING EQUIPMENT OUT OF SERVICE
AND RESTORING TO SERVICE

These instructions cover the methods which shall be used for taking equipment out of service on account of trouble, for routine tests other than by routine testing apparatus, or for inspection or check, also for subsequently restoring it to service.

It should be noted that these instructions cover only cases where the apparatus is to be taken out of service for the reasons mentioned above. In cases where apparatus is in trouble and involved in a connection it is assumed that the trouble routine has been carried out up to the point where the fault has been located in the apparatus to be taken out of service.

Following is a list of the equipment so covered.

Subscribers Line Switch.

District Selector. (Individually and by half frames)

Office Selector.

Incoming Selector - Full mechanical. (two wire)

Incoming Selector - Full Mechanical. (three wire)

Incoming Selector - Cordless.

Final Selector.

Subscriber's Sender.

"A" Operator's Sender.

"A" Operators' District Selector.

Cordless "B" Sender.

Cordless "B" Link Circuit.

Cordless "B" Allotter.

Cordless "B" Key Set.

Cordless "B" Key Control.

Interrupters

Trunks in District. Office and Incoming multiple.

Subscriber's lines in final multiple.

Frames. (Account of Multiple Bank Charges)

Line Finder Multiple Banks.

Translator Multiple Banks.

Trip circuits Line Finder System.

Start Circuits Line Finder System.

District Selector Line Finder System.

Local District Selector.

Local District Sender.

Subscriber's Line Switch

To take out of service.

- (a) If normal, block armature of "L" relay to prevent operation.
- (b) If off normal, await disconnection and block "L" relay as in (a).

If switch fails to return to normal on disconnection, restore to normal by hand and block "L" relay as in (a).

To restore to service.

Remove blocking device from "L" relay.

District Selector (Individual Line-Switch)

To take out of service.

- (a) If normal, place district make busy plug in "Test Make Busy" jack.
- (b) If in talking position, place plug as in (a) and

selector should return to normal on disconnection.

If selector does not return to normal on disconnection, verify the fact that the subscriber has disconnected and move sequence switch to position 18 by hand when selector should return to normal.

- (c) (1) If selector has chosen trunk but not advanced to talking position, place plug as in (a) and trace connection to determine if office or incoming selectors are involved.

(2) If office selector is involved and has not chosen an incoming trunk, move office sequence switch to position 11 (overflow) from which it should return to normal indicating release of associated district selector.

If office selector fails to restore from position 11, move associated district sequence switch to position 18, when both selectors should return to normal.

(3) If office selector involved has chosen an incoming trunk have incoming made busy, release as in (2) and have incoming restored and busy plug removed.

- (d) If off normal, but has not chosen an office trunk, place plug as in (a) and move sequence switch to position 18, from which it should return to normal.

To restore to service.

Place in normal position and remove plug from "Test Make Busy" jack.

District Selectors (By Half Frames) (Line Switch Offices)

To take out of service.

Operate "Frame Busy" key.

To restore to service.

Restore "Frame Busy" key.

Office Selectors.

To take out of service.

- (a) If normal, place plug in "Make Busy" jack.
(b) If in talking position, place plug as in (a) and

trace to incoming. If an incoming is involved, release connection as described in (C-3) under District Selector.

- (c) If in some position other than in (a) and (b) proceed as in (b).
- (d) If off normal and has not picked a trunk, place plug as in (a), and release as described in (c-2) under District Selector.

To restore to service.

Remove plug from "Make Busy" jack.

Incoming Selectors. (Two wire)

To take out of service.

- (a) If normal or in talking position, place make busy plug in "Make Busy" jack.
- (b) If off-normal and not in talking position, place make busy plug as in (a) and release as described in (c-3) under District Selector.

To restore to service.

Remove plug from "Make Busy" jack.

Incoming Selectors. (Three Wire)

To take out of service.

- (a) If normal or in talking position, place make busy plug in "Make Busy" jack.
- (b) If off normal and not in talking position, place plug in same manner and release as described in (c-3) under District Selector.

To restore to service.

Remove plug from "Make Busy" jack.

Cordless "B" Incoming (All Types)

To take out of service.

Wait until trunk is idle, place fibre trouble cap over assignment key and operate disconnect key.

If selector does not restore on operation of disconnect key, move sequence switch to position 18 when selector should return to normal.

To restore to service.

Remove fibre trouble cap from assignment key.

Final Selector.

To take out of service.

- (a) If selector is normal or in talking position, place plug in "Make Busy" jack.
- (b) If in any other position, make busy as in (a) and move sequence switch to position 15 from which it should return to normal. If it does not return to normal, trace back to district and move district sequence switch to position 18 when all selectors should restore.

To restore to service.

Remove plug from "Make Busy" jack.

Subscriber's Sender.

To take out of service.

- (a) If not "stuck", place make busy plug in "Make Busy" jack at sender monitor.
- (b) If "stuck" and cannot be released from sender monitor, place busy plug as in (a) and release sender and associated selectors, as described under District and Incoming Selectors.

To restore to service.

Remove plug from "Make Busy" jack.

"A" Operator's Sender Circuits.

Sender Selector.

To take out of service.

- (a) If in position 9 or 18, operate make busy key, and move sequence switch to position 9 or 18 by hand.

To restore to service.

Restore key to normal.

Sender.

To take out of service.

- (a) If normal, place plug in "Make Busy" jack.
- (b) If stuck, place plug as in (a) and release district selector as described under "Sender Selector". If sender does not restore to normal it shall be moved to this position by hand.

To restore to service.

Make sure that sender progress lamp is out and remove plug from "Make Busy" jack.

"A" Operator's District Selector.

To take out of service.

- (a) If normal, place trouble cap on plug
- (b) If "stuck", place trouble cap as in (a) and release by turning sequence switch into talking position.

To restore to service.

Remove trouble cap from plug.

Cordless "B" Sender.

To take out of service.

- (a) If not "stuck", place plug in "Make Busy" jack.
- (b) If "stuck", place make busy plug as in (a) return to normal by hand and operate disconnect key of cordless unit which was involved.

To restore to service.

Remove plug from "Make Busy" jack.

Cordless "B" Link Circuit. (Sender Selector)

To take out of service.

- (a) If in position 17; operate make busy key.
- (b) If in position 1, move out of 1, wait until it reaches 17 and proceed as in (a).

- (c) If in position other than 1 or 17, wait until sequence switch reaches 17 and operate make busy key.
- (d) If "stuck" in selecting position, operate make busy key and note that allotter properly assigns next sender selector circuit.

To restore to service.

Restore key to normal.

Cordless "B" Link Allotter. (Front or Rear)

To take out of service.

- (a) Operate make busy keys of idle sender selectors controlled by allotter and also of busy ones as they become idle.

Remove connecting plug of allotter involved from position, insert in trouble position, and restore all make busy keys.

To restore to service.

Advance allotter to position 7 or 16, remove connecting plug from trouble position and place in regular position.

Cordless "B" Key Set.

To take out of service.

Remove regular key set from keyboard and replace with spare set of same type.

Spare key sets placed on account of trouble will be retained in service. The set removed will be repaired and held for as a spare.

Cordless "B" Key Control Circuit.

To take #1 key control circuit out of service.

Remove regular plugs from jacks "C", "E" and "F"

To restore to service.

Restore regular plugs to jacks "C", "E" and "F"

To take #2 key control circuit out of service.

Remove regular plugs from jacks "D", "G" and "H".

To restore to service.

Restore regular plugs to jacks "D", "G" and "H".

Key control circuits may be borrowed from other positions to replace those which may be in trouble. In every case they shall be of the same kind, also A#1 circuit can be used only to replace A#1 or A#2.

To replace key control circuit #1 of any position with a key control circuit "borrowed" from another position.

Remove regular plugs from jacks "G", "E" and "F" of key control circuit to be taken out of service, and of circuit to be borrowed and connect jacks similarly designated in the two circuits by means of proper patching cords.

To replace key control circuit #2 of any position with a "borrowed" circuit.

Remove regular plugs from jacks "D", "G" and "H" patch to jacks "D", "G" and "H" of "borrowed" circuit.

To restore to service.

Place sequence switch in position 9 or 18, remove patching cords and replace regular plugs in regular position.

Interrupters.

In general when interruptors are stopped which adjustment or repairs the apparatus with which they are associated shall be taken out of service in accordance with the routine provided therefor.

In future installations emergency interruptor equipment will be furnished in some cases in which event it shall be used where necessary.

TRUNKS AND SUBSCRIBERS LINES TAKEN OUT OF SERVICE
DUE TO TROUBLES IN MULTIPLE BANKS.

The following instructions describe the method of taking equipment out of service due to troubles which may occur in multiple banks, the method of continuing service in the case of final terminals, also the method of temporarily establishing circuits where multiple banks are to be changed.

Individual Lines District Office and Incoming Multiple.

Where one or two individual terminals are found to be in trouble it will not be necessary to change the bank provided that the remaining trunks are sufficient to care for the traffic and the terminals involved will be taken out of service.

If the trouble is due to a cross and the frame is part of a "line up" permanently ground the sleeve at the frame, disconnect the tip ring and sleeve wires and splice through to the next frame. If the frame is the last one of a "line up" the tip-and-ring wires shall be disconnected and taped.

If the trouble is due to a broken terminal "make busy" the selector which has access to the trunk involved. In case that it is desired to keep the selector in service it may be transferred to another location if space is available.

Subscribers Lines. (Final Multiple Banks)

(a) Individual lines and party lines.

- (1) Sleeve grounded. Cross connect line to new terminal and old terminal (T&R only) to special ringdown intercepting trunk.
- (2) Sleeve crossed with its own ring. If next terminal above one in trouble is vacant transfer line to this and wire sleeve of abandoned terminal as a busy P.B.X. line.

If next terminal is not vacant transfer line to some other vacant terminal and cross-connect vacated terminal (T-R-S) to a special ring-down intercepting trunk.

- (3) Sleeve crossed with tip of terminal below.

Cross connect both lines to new terminals, and upper vacated terminal to intercepting trunk and wire lower vacated terminal as a P.B.X. line.

- (4) Ring grounded. If terminal above is vacant transfer line to this terminal and wire sleeve of abandoned terminal as a busy P.B.X. line. If terminal above is assigned for service other than P.B.X. transfer the line in trouble to a new terminal and cross-connect vacated terminal to a final intercepting trunk.
- (5) Ring and tip crossed. Proceed as in ring ground (4)
- (6) Tip grounded. If terminal above is vacant transfer line to this terminal and wire vacated terminal as a busy P.B.X. line. If the terminal above is not vacant transfer the line in trouble to some vacant terminal and cross connect vacated terminal to a final intercepting line.

(b) P.B.X. Lines.

- (1) First line P.B.X. Group. (Sleeve Grounded)

Cross connect defective terminal (T&R) only to special ring-down intercepting trunk or connect battery to sleeve through proper resistance to give busy P.B.X. condition.

Note: If one intercepting trunk will not be sufficient for all calls, this method cannot be employed and multiple bank shall be changed.

- (2) First Line P.B.X. group. (Sleeve Crossed with Ring)

Disconnect line from terminal and connect sleeve of terminal as busy P.B.X. line. If terminal above last terminal in P.B.X. group is vacant connect line thereto and wire this as the last terminal in the group changing the sleeve of the regular last line to other than last P.B.X. line.

If no vacant terminal is available no temporary arrangement can be provided. If however, there is a vacant terminal preceeding the P.B.X. group this may be added to the group, but the line can only be used for originating calls.

- (3) First line P.B.X. group. (Sleeve crossed with line below))

This will interrupt service to the entire group, and if terminal with which it is crossed is in use no temporary arrangement is possible.

In the meantime the line below shall be changed to a new terminal and the vacated terminal made busy.

If it is possible to change the numbers of the P.B.X. group they shall be transferred to new terminals, as also shall the line below. The line below and all of the P.B.X. group shall be wired as busy P.B.X. lines, and the last P.B.X. line shall be wired to an intercepting trunk.

- (4) First line P.B.X. group. (Ring Gd. short circuit or tip grounded).

Proceed as in first line P.B.X. group sleeve crossed with ring (2)

- (5) Intermediate P.B.X. line. (Sleeve grounded).

Have P.B.X. operator confine outgoing service to lines above one in trouble, and disconnect this line.

If numbers of P.B.X. can be changed transfer lines to new terminals and cross-connect defective terminal to special ring-down trunk. The other abandoned terminals above and below one in trouble shall be arranged as separate P.B.X. groups, and connected to intercepting trunks.

- (6) Intermediate P.B.X. line. (Sleeve crossed with ring).

Proceed as first line P.B.X. group, sleeve crossed with ring (2).

- (7) Intermediate P.B.X. line. (Sleeve crossed with tip below)

If there is a vacant terminal above the group transfer thereto line on terminal below one which is defective and connect as last P.B.X. line. Original last line shall be wired as regular P.B.X. line and vacated terminal as busy P.B.X. line.

If no vacant terminal is available and numbers of P.B.X. group can be changed they shall be transferred to new terminals.

Last abandoned terminal shall be wired to intercepting trunk and other abandoned terminals as busy P.B.X. lines.

If no vacant terminal is available no temporary arrangement is possible.

- (8) Intermediate P.B.X. line. (Ring grounded, ring crossed with tip or tip grounded).

Proceed as in first line P.B.X. group, sleeve crossed with ring (8).

- (9) Last Line P.B.X. group. (sleeve grounded).

If number cannot be changed and subscriber needs all trunks no temporary arrangement is possible. If all trunks are not needed terminal preceeding one in trouble shall be made the last P.B.X. line, defective one abandoned and connected to special ring-down trunk (T&R only).

If a vacant terminal preceeds the group it may be included therein and used for outgoing service in connection with the line affected.

The abandoned terminal shall be wired to a special ring-down intercepting trunk (T&R) only.

- (10) Last line P.B.X. group. (Sleeve crossed with ring).

If vacant terminal is above one in trouble transfer line thereto, arrange sleeve as last P.B.X. line and abandoned terminal as busy P.B.X. line.

If no vacant terminal preceeds or follows the group or a number change is not possible the bank shall be changed.

- (11) Last Line P.B.X. group. (Sleeve crossed with tip of line below).

Proceed as in intermediate P.B.X. line sleeve crossed with tip of line below (7).

- (12) Last line P.B.X. group. (Ring grounded, ring crossed with tip or tip grounded).

Proceed as in last line P.B.X. group sleeve crossed with ring (10).

- (13) Last Line P.B.X. group. (Tip crossed with sleeve of line above).

If terminal above is vacant transfer line thereto; wire as last P.B.X. line and wire abandoned terminal as busy P.B.X. line.

If no vacant terminal is available, wire next to last terminal as last P.B.X. terminal, connect original last terminal as busy P.B.X. line and transfer line on terminal above original last terminal to new terminal. This abandoned terminal shall be connected to an intercepting trunk and wired as a last P.B.X. Line.

If a vacant terminal precedes the P.B.X. group this may be added to the group.

General

Where a terminal is abandoned or wired to an intercepting circuit the line switch shall always be disconnected.

In using the various schemes outlined in connection with trouble in final multiple banks it should be appreciated that the object is to furnish temporary service pending the change of the multiple bank. At the same time it is to be noted that subscribers numbers are involved and in some cases the method employed necessitates number changes, not only of the subscriber directly affected, but also of those having adjacent numbers.

In cases where number changes are involved permission to make such changes shall be secured from both the Traffic and Commercial Departments, and their decision in the matter will determine as to whether the number changes or irregular operating features are permissible.

If the objections are such that the desired result cannot be obtained it will be necessary to change the multiple bank as soon as possible as service on the line or lines involved will be interrupted until the change is made.

where number changes or abandonment of working terminals are not involved the Traffic Department will decide as to whether or not the arrangement is permissible.

In these cases the change of the bank may be deferred until such time as the conditions are favorable for making the change, which eventually will have to be made as the temporary use of blank lines reduces the number available for assignment in connection with new business.

All rearrangements involving number changes, abandonment of terminals, intercepting of service, etc., shall be handled with the Traffic Department in accordance with the established routine covering these features.

Taking Frame Out of Service While Changing Multiple Bank. (District Office and Incoming).

The work of changing multiple banks shall be done during period of lightest load.

If the frame is so located that trunks will be open to other frames, sufficient trunks to carry the traffic to each group involved in the change shall be temporarily wired around the bank to be removed. All other trunks involved shall be made busy on both sides of the bank to be removed.

All selectors on the frame where the change is being made shall be made busy.

If frame where change is being made is located at the end of the multiple proceed as above, except that it will not be necessary to provide wiring around the bank to be changed. In this case care should be taken to avoid crossing or grounding the wiring while the work is in progress.

Taking Frame Out of Service While Changing Multiple Bank. (Final).

The work of changing multiple banks shall be done during the period of lightest load.

- (a) If the final frame is not multiplied and service can be interrupted on all lines in the frame.

Select one or two trunks from each sub-group to the final frame, toothpick proper sequence switch springs of final to clear tip ring and sleeve conductors from final apparatus. Associate these circuits with blank incoming choice circuits by plugging switchboards

cords into the test jacks of finals selected. This will route calls for the lines out of service to the special operator, who will advise the calling subscribers accordingly.

All finals not patched as above shall be made busy.

Where service is to be maintained on certain lines, these shall be temporarily cross-connected to spare terminals in some other frame.

Calls for the lines so treated will reach the special operator who will advise the calling party to dial the temporary number.

In the event that a spare final frame is available lines on which service is to be maintained will be cross-connected to terminals on this frame in the same relative position as they appear on their regular frame, all other terminals on the spare frame being strapped and wired to a "Blank final" line to the intercepted operator.

Patch one final circuit in each group on the frame out of service to spare frame final circuits by means of patching cords between the respective "T" jacks.

The circuits patched on the frame out of service shall be opened towards the final apparatus by toothpicking the proper sequence switch springs.

All finals on the frame out of service not patched shall be made busy.

- (b) If the final frame is multiplied and at the beginning of the multiple, select one or two final circuits in each group on the frame out of service and patch them to final circuits on the nearest final frame by means of patching cords between the respective "T" jacks. The circuits patched on the frame out of service shall be opened towards the final apparatus by toothpicking the proper sequence switch springs. All "borrowed" selectors and all selectors not patched from the frame out of service shall be made busy.

Lines in the bank to be removed, on which service is to be maintained shall be extended from the end of the multiple to their I.D.F. terminals by means of temporary wiring.

No provision is made under this scheme for intercepting service on lines in the bank out of service on which service is not maintained.

- (c) If the final frame is multiplied and in the middle or the last in the multiple line up, select one or two final circuits from each sub-group of the frames affected by the change and patch them to final circuits on the first final frame by means of patching cords between the respective "T" jacks. The circuits patched on the affected frames shall be opened towards the final apparatus by toothpicking the proper sequence switch springs.

All "borrowed" selectors on the first frame and all selectors on the affected frames which are patched shall be made busy.

Line Finder Banks.

Lines working in line finder banks shall be taken out of service by transferring the associated circuits to spare terminals and troubles affecting them will necessitate that the bank be changed as soon as possible. When line finder banks are changed it will be necessary to shut down the frame involved. In this case lines on which service is to be maintained will be temporarily transferred to terminals in another line finder frame.

Translator Banks.

Individual terminals in translator frames cannot be taken out of service and troubles affecting them will necessitate that the bank be changed as soon as possible. When multiple banks on translator frames are changed the senders having access thereto shall be made busy.

Trip Circuits. (Line Finder System)

To take out of service.

- (a) If not in use remove patching plug in jacks #1 to 14 and place in jacks 15 to 27.
- (b) If in use await disconnection and proceed as in (a).

To restore to service.

Replace patching plug in normal position.

If circuit is in use, await disconnection before moving patching plug.

Start Circuits. (Line Finder System).

To take out of service.

- (a) If not in use remove patching plug in jacks #1 to 18 and place in jacks #19 to 36.

- (b) If in use await disconnection and proceed as in (a).

To restore to service.

Replace patching plug in normal position.

If circuit in use, await disconnection before moving patching plug.

District Selector. (Line Finder System)

To take out of service.

- (a) If normal place plug in "make busy" jack.
- (b) If off normal and in use for service await disconnection and place plug as in "A".
- (c) If not in use and off normal and no selectors beyond are involved place plug as in (a) and move switch to 18 from which it should return to normal.
- (d) If not in use and off normal and selectors beyond are involved place plug as in (a) release other selectors as described under District Selectors, Line Switch system, and move switch to 18 from which it should return to normal.

To restore to service.

Remove plug from "make busy" jack.

Shutting Down Frames to Repair Driving Apparatus.

- (a) District Frames. Operate frame busy key on the side of the frame affected.
- (b) Office, Incoming and Final Frames.

Make busy all selectors on side of frame affected by placing make busy plugs in the "make busy" jacks.

Local District Selector.

To take out of service and restore to service.

Proceed as outlined under District Selector. (Individual)

Local District Sender

To take out of service.

- (a) If not "stuck" place make busy plug in "Make Busy" jack.
- (b) If "stuck" place make busy plug as in (a) and release by disconnecting associated district selector as outlined under District Selector.

TOOLS AND GAUGES

To assist in obtaining the mechanical adjustments on the relays as specified under the mechanical requirements of the particular relays, certain tools and gauges have been designed so that the relays may be adjusted with little difficulty.

These tools and gauges are shown on Figures #4 and #4A which show the code number identifying them. No tools other than those shown shall be used to adjust the relays.

For those relays where thickness gauges or the turns of a screw are specified to be used for obtaining the proper armature travel, the maintenance man shall understand that it is essential that these dimensions should be obtained.

The following table indicates the particular gauges and tools to be used for each of the various types of relays:

Standard Tools for Panel Type Machine Switching Offices

Tools for use on Relays

<u>Name of Tool</u>	<u>Code No.</u>	<u>Used on</u>
Armature air-gap adjusting gauge	Gauge #64-A	Flat type relays
Armature air-gap adjusting gauge	" #66-A	" " "
Relay Spring Tension Gauge (50 gram)	" #70	" " "
Off-set screw driver (30°)	Tool #206	" " "
Off-set screw driver (90°)	" #207	" " "
Wrench for stud nut (3/16" hex.)	" #231	" " "
Relay contact clip	" #252	" " "
Spring adjusting tool	" #259	" " "
Wrench for pivot screw nut (7/32" hex.)	" #208	#207 Relay

<u>Name of Tool</u>	<u>Code No.</u>	<u>Used on</u>
Contact air-gap gauge (.003", .004", .005" & .006")	Gauge #74-A	#208 Relay
Armature air-gap gauge (.007" -.008")	" #73-B	" "
Armature air-gap gauge (.018" -.022")	" #73-A	" "
Armature Spring Lug & Contact Lug Adjuster	Tool #264	#208 Relay
Screw driver	" #35	Nos. 114, 125, 198 and 207 Relays
Air-gap adjusting gauge (.034")	Gauge #41	No. 114 "
Air-gap adjusting gauge (.015")	" #42	Nos. 177, 198, 203 and 207 Relays
Wrench, relay mounting socket (5/16" hex.)	Tool #102	Nos. 114 and 124 Relays
Spring adjusting tool	" #50	Nos. 149, 162 and 178 Relays
Spring adjusting tool	" #98	Nos. 177 and 203 Relays
Wrench, combination relay adjusting (5/16" hex.)	" #219	Nos. 144, 124, 198 and 207 Relays
Wrench, combination relay adjusting (3/16" hex.)	" #220	Nos. 144, 124, 198 and 207 Relays
Extractor, message register cap	" #90	Message Register
Contact Burnisher	" #265	All Relays
Adjusting Tool for Pole Pieces and Contact Stud Screws	" #212	No. 206-B and #209-A Relays
Relay Wedge	" #136	Flat Type Relays

MECHANICAL REQUIREMENTS OF RELAYS

General.

By mechanical requirements or adjustments are meant the armature travel, contact separation, spring tension, spring follow, spring position, etc. Careful attention to these matters as the first step in the adjustment of the relay is fundamental. The meeting of the electrical requirements is the second step and is thereby greatly facilitated, a more stable adjustment being secured.

On every occasion when the maintenance man inspects or adjusts a relay, he should make certain that it meets the mechanical requirements as well as the electrical requirements. If the relay cannot be made to meet the requirements, and the chief switchman deems the margin of safety of operation in the particular circuit is small, the relay should be removed; otherwise it should be retained.

Preliminary Inspection.

Before the relay is adjusted to specified requirements involving the cause of gauges or current requirements, a visual inspection shall be made to see that the relay meets the following requirements:

1. The relay should be mounted level and securely fastened to the mounting plate. By "mounted level" means that the relay base or part supporting the armature shall be level both from right to left facing the relay and from front to rear.
2. All parts should be securely fastened and all nuts and screws set up tightly. Nuts on adjusting screws should be set up moderately tight.

3. All spring pile-ups should be fastened securely and springs should be in alignment. If necessary to adjust a spring pile-up, see that all screws are again set up tightly. The offset screw drivers, Tools #206 and #207, are designed to be used in tightening spring pile-ups on installed relays. The spring contacts should be centered. Contacts are centered if the entire contact point rests on the corresponding disc.
4. Relay cover should fit properly and should never be fastened with a tool of any kind. Care should be taken not to use the cover itself as a lever in order to fasten the nut on relays of the #149 type.
5. Armatures should not stick but should be easily moved. When pivot screws are used to support the armature, there should be a little end play.

Contact Cleaning

Experience has shown that dirty contacts is one of the chief sources of relay trouble. The majority of the troubles are open or high resistance contacts caused by a coating of dirt. Although this film of dirt may not be noticeable, the maintenance man should understand that whenever he has occasion to adjust a relay it will be well to clean the contacts.

The following is the standard method of cleaning relay contacts:

The contacts should be cleaned by rubbing the standard contact burnishing tool #265 back and forth five or six times in a manner so as to keep the surface of the tool flat against the surface of the contact disc. At the same time the point contact should be allowed to press (or made to do so manually) against the other side of the burnishing tool. Abrasives such as fine files or emery cloth should never be used on contacts.

The practice outlined in the preceding paragraph will be sufficient in most cases. Where further trouble is experienced and there is some indication of pitting, with the point of a toothpick (one end flat) take up a drop of the chemically pure carbon tetrachloride (Merck's) and deposit it on the contacts, which should be held slightly separated. Then dip the flat end of the toothpick in the liquid to a depth of about one-quarter inch and rub back and forth two or three times between the contacts, which should be allowed to close with a slight pressure on the flat sides of the toothpick. The liquid will soften the deposit that may have collected on the contacts and the rubbing will remove it. Then with the contacts again held slightly open, take up a little of the liquid on the clean point of the toothpick (not the end used for rubbing) and flush the contacts to wash off any loose particles that may remain. Then discard the toothpick. It is important that a clean toothpick be used for each pair of contacts, as it has been found that otherwise the deposit removed from one contact might be left in the liquid and later deposited on another relay. Care should be taken to keep the liquid from coming in contact with the rubber studs or insulators, as carbon tetrachloride has an injurious effect on rubber.

If there is an indication of serious pitting due to arcing, crocus cloth #00 may be used with discretion. It should be pulled back and forth between the contacts, which should be

allowed (or made to do so manually) to press together. After this treatment, the contacts should always be treated with carbon tetrachloride as outlined in the preceding paragraph.

SPECIAL FEATURES & MECHANICAL REQUIREMENTS OF INDIVIDUAL
TYPES OF RELAYS

The following is a brief description of the features peculiar to each type of relay with the mechanical requirements for that relay.

The following relays are described:

<u>Type No.</u>	<u>General Type</u>	<u>Generally Used As</u>
B	Flat	Supervisory
E	"	Control or Signal
G	"	Supervisory with laminated core ("B" Type)
H	"	Control or signal with laminated core ("E" Type)
87	Gravity	Ringling, Signal
114	Round, Iron-clad	Ringling, Tripping
124	" "	" "
149	Round	Slow Operating Relay
162	"	" " "
177	Polarized (2-coil)	Control or Signal
178	Round	Slow Operating Relay
198	Round, Iron-clad	Ringling, Tripping
203	Polarized (2-coil)	Control or Signal
206	Polarized (1-coil)	Control or Signal
207	Telegraph	Stepping
208	Side-Armature	Counting
209	Polarized (1-coil)	Control or Signal
	Solenoid or Dashpot	Timing

"B" and "G" Type Relays

Special Features:

The "B" type of relay is designed to operate over a wide range of current values since the current through the relay is determined by the length of the trunk or subscribers line. This relay is a fairly sensitive relay and is usually of low resistance.

This type relay must be adjusted very carefully and means are provided for easily doing this by the use of screws set into a plate. Tension is applied to the various contact and armature springs by turning these screws as required with a screw-driver. The springs are inaccessible for any other means of adjustment, as a cover is provided which encloses the relay. This cover cannot be removed when the relay is mounted on the relay rack and is made of thin sheet iron which prevents any magnetic interference from other relays adjacently located.

A cap is provided to set into the front of the cover so as to prevent dust from resting on the contacts which project through the brass plate holding the adjusting screws.

The "B" type relay was designed to be used primarily as a supervisory relay but it is also used in other signaling circuits where a fairly sensitive relay is required.

The "G" type relay is the same design as the "B" type with the exception that the core is laminated or made of a number of thin plates of iron instead of being in one piece as is the case in the "B" type. This form of core improves talking transmission when the relay is used for supervisory purposes.

The movable screw method of adjusting the contact springs is provided on the "G" type relay. Figure #5 shows the "B" type relay with the cover removed.

Tools Required

Gauges

65-A .013"

65-B .018"

65-C .013"

65-D .023"

Above gauges on
a ring 64-A

Tools

35 Screw Driver

265 Contact Burnisher

Crocus Cloth #00

Toothpicks

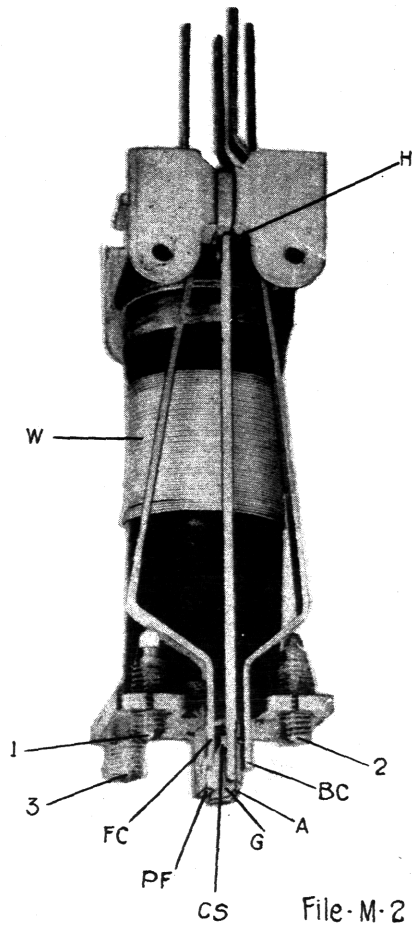
Carbon Tetrachloride

Relay Adjusting Set

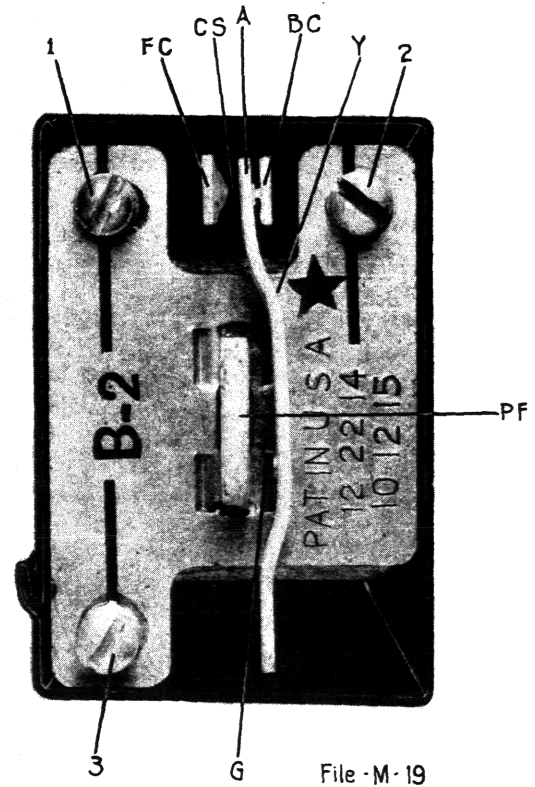
Mechanical Adjustment

The adjusting screws "1", "2" and "3" (Fig. 5) should be sufficiently tight to prevent turning by fingers. If not, it will be necessary to remove the relay from the mounting and remove the relay cover. Then remove the screw and close the slotted hole slightly with pliers.

See that the contacts are centered. Contacts are considered centered if the entire contact surface of the contact point rests on the discs. If the tops of the front contact "FC" armature "A" and back contact "BC" (See Figure 5) are almost on a straight line, parallel to the top of the relay cover, the contacts will generally be on center.



Top View



Front View (enlarged)

Fig. 5 B&G Type Relays - Armature in Normal Position.

While thickness gauges are recommended in the following paragraphs for setting the normal and operated positions of the armature, in many cases the relays will be located so that the adjustments can be made only with considerable difficulty unless the closure of the contacts is indicated by the operation of some relay or signal in the circuit.

Normal Position of Armature

In order to insure the most efficient operation of the armature, and where a back contact is employed, to insure the maximum back contact pressure, the armature travel as specified in Fig. 6 should be obtained by means of the thickness gauges as follows, -

<u>Spring Combination</u>	<u>Gauge</u>	<u>Clearance between Armature in Normal Position and Pole Face</u>	<u>Minimum Armature Travel</u>
Nos. 1-2-3-4-6-8-9-	65-B	.018"	.010"
" 5-7	65-D	.023"	.015"

On spring combinations 1, 2, 3, 4, 6 and 8 with the gauge in place, the rigid back contact "BC", or back stop "BS" should be located so that it just touches the armature.

On spring combination 9 with the gauge in place, the flexible back contact "BC" should be located so that after the gauge is removed and the armature moved toward the pole face manually, it will follow the forward movement of the armature approximately .005"; that is, it will have a .005" "follow."

On spring combinations 5 and 7 with the gauge in place, locate the rigid front contact "RFC," so that the stud thereon just touches the armature, then adjust the flexible short traveling spring "STS" attached to the armature so that there is a minimum clearance of .005" between its contact point and the rigid front contact. This adjustment insures that the short traveling spring will engage the front contact approximately .005" before the other front contact is made.

Armature Spring Tension

Regulate the armature spring tension to enable the relay to meet its electrical requirements. On spring combinations 1, 2, 3, 5, 6 and 8 (See Fig. 6) turning screw "3" forward (to the right) increases the armature spring tension and turning it back (to the left) decreases the tension. For spring combinations 4, 7, and 9 (See Fig. 6) the adjusting plate is reversed, having the armature spring tension screw in the lower right hand corner. Turning this screw forward (to the right) decreases the spring tension on the armature as it exerts a forward tension on the armature spring, thus aiding the armature to overcome the pressure exerted on it by the flexible traveling spring "TS". Turning the lower right hand screw back (to the left) on these same spring combinations increases the spring tension on the armature as it decreases the tension of the armature spring and thus the flexible traveling spring exerts more pressure on the armature.

When rigid front contacts are employed such as on spring combinations 1, 2, 3 and 5, it is not essential that the armature stop pin touch the pole face when the relay is operated electrically on its "operate" current.

When flexible front contact springs or flexible traveling springs are employed such as on spring combinations 4, 6, 7, 8 and 9, it is essential that the armature stop pin touch the pole face when the relay is operated electrically on its "operate" current.

Operated Position of Armature

In order to insure the proper front contact pressure and to aid the armature to release promptly when the current is removed from the relay, the front spring "FS" or front contact "FC" (See Fig. 5 and 6) should be located so that the armature "A" or the traveling spring "TS" will engage the front spring or front contact, before reaching its fully operated position. To obtain this adjustment thickness gauges should be used as follows:

<u>Spring Combination</u>	<u>Gauge</u>	<u>Clearance between Armature in operated position and pole face</u>
No. 1-2-3-4-6-8-9	65-A	.013"
" 5-7	65-C	.013"

With the proper gauge in place the armature is held .013" from the pole face "PF"; the stop pin not affecting this position since the gauge is cut away at this point. The front spring or front contact should be located so that it just touches the armature or the traveling spring, as the case may be.

On spring combinations 1, 2, 3 and 5, which have rigid front contacts and are not equipped with long flexible traveling springs, with the gauge removed and the armature held against the pole face manually (without forcing the front spring or front contact back), this adjustment will result in an air gap slightly greater at the upper part of the pole face than at the lower part, that at the lower part being due to the approximately .008" stop pin.

On spring combinations 4, 6, 7, 8 and 9, which have flexible front contact springs or long flexible traveling springs, with the gauge removed and the armature held against the pole face manually, this adjustment will result in a "follow" (approximately .005") on the flexible front contact or long traveling springs.

On spring combinations 1, 2, 3 and 5, locate the front spring so that when the armature is pushed slowly forward with the blade of a small screw-driver at the point "Y" (See Fig. 5), there will be a slight rocking motion of the lower part of the armature until the stop pin touches the pole face.

On spring combinations 4, 6, 7, 8 and 9, locate the front contact or front spring so that when the armature is in its operated position there will be a visible "follow" (not less than .005") on the flexible front contact spring or traveling spring.

SPRING COMBINATIONS OF B TYPE RELAYS

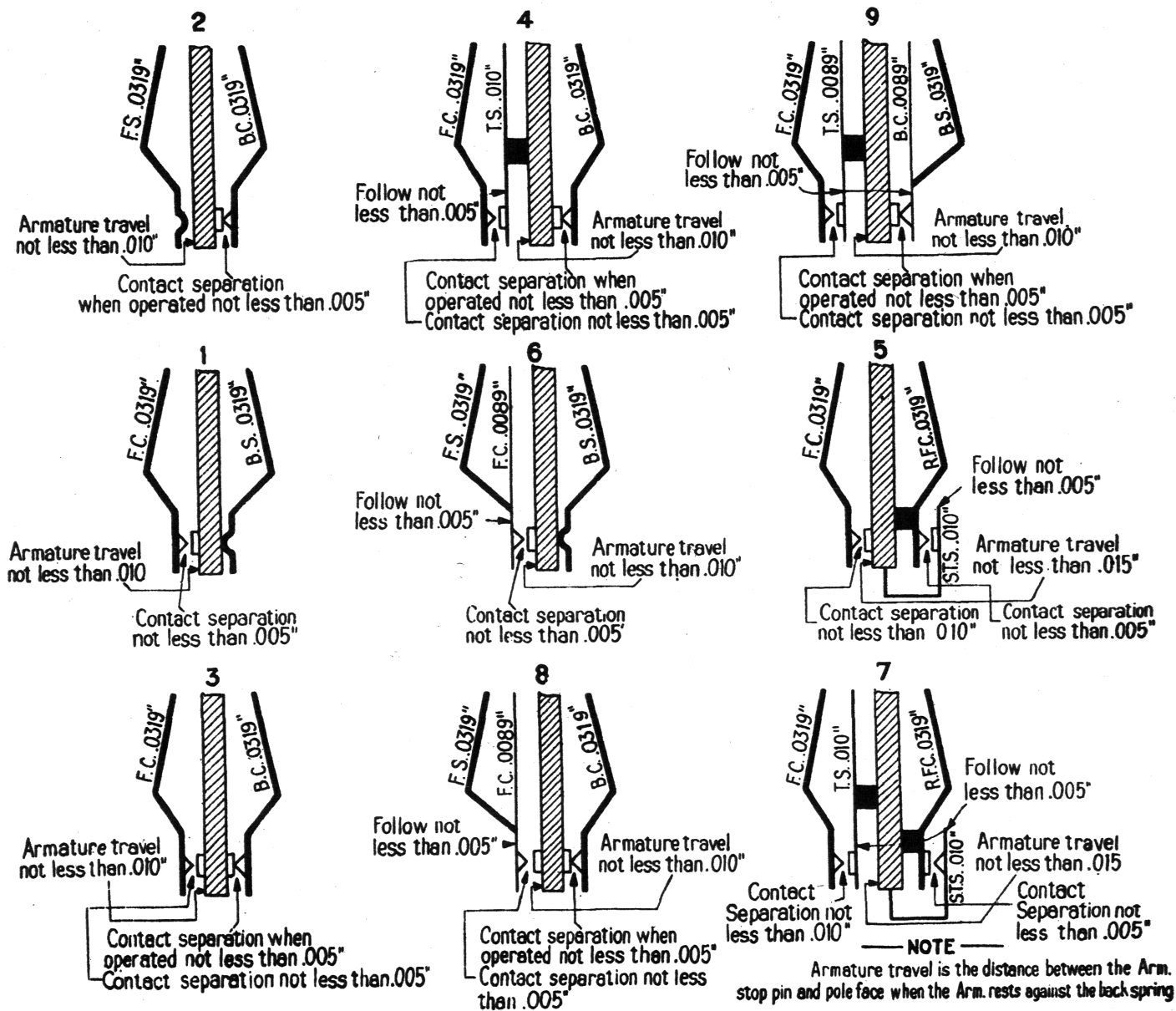


Fig. 6, B & G Type Relay Spring Combinations.

"E" and "H" Type Relays

Special Features:

The "E" type relay is a flat relay similar to the "B" type with the exception that the contact springs are adjusted by bending the springs as the movable screw method of adjustment is not provided. The individual relay cover is not provided on the "E" type relay, all "E" type relays on a mounting plate being covered by a long common cover. This relay is used for controlling or signaling purposes and is not used where the variation in current is great or for supervisory purposes. A larger core is provided on "E" type relays which makes it possible to use more and heavier contact springs than are provided on the "B" type. This makes it possible to have a greater contact pressure and thereby allows the circuits closed by the contacts to carry more current. The construction of this relay renders the spring combinations easily accessible for maintenance, owing to the fact that the plane of the springs is vertical which also eliminates as far as possible any chance of maintenance difficulties due to dirt or dust collecting on the contacts.

The "H" type of relay is the same as the "E" type, with the exception that the core is laminated instead of solid.

"E" and "H" type relays when mounted on one plate are covered by a long relay cover when not being tested or adjusted. Care should be taken in placing or removing the cover not to cause it to come in contact with the relay springs.

Figures #7 and 8 show an "E" type relay.

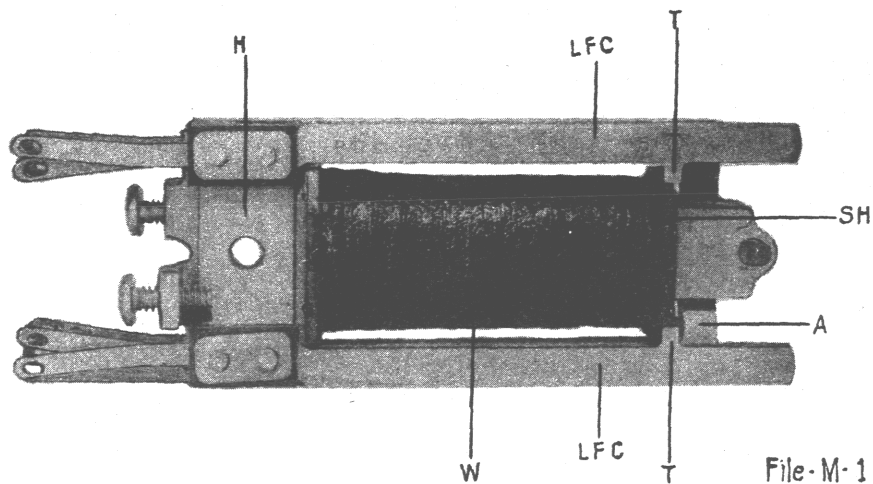


Fig. 7. "E" Type Relay (side view)

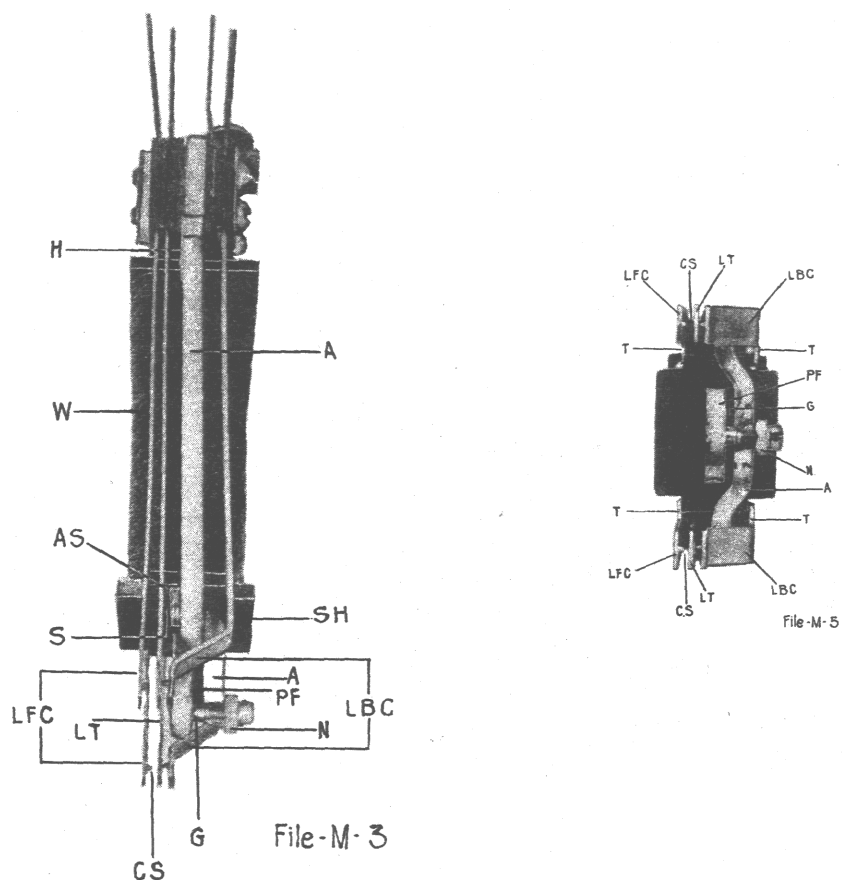


Fig. 8. "E" Type Relay (top and front)

Tools Required

<u>Gauges</u>	<u>Tools</u>
67-A .015"	231, Wrench
67-B .020"	206, 30° Off-set screwdriver
67-C .025"	207, 90° Off-set screwdriver
67-D .030"	259, Spring bender
67-E .035"	35, Screw Driver
67-F .040"	265, Contact Burnisher
Above gauges on a ring 66-A	Crocus Cloth #00
	Tooth Picks
	Carbon Tetrachloride
	Relay Adjusting test set
	136, Wedge

Mechanical Requirements:

All springs, except normally bent springs, should be straight, especially toward the contact ends, (except in certain cases which will be covered by specific instruction.)

The armature studs "AS" (see Fig. 9) should not rub on the springs through which they pass and the ends of the tangs "T" on the springs should not rub on the sides of the spool head "SH".

Armature stop nut "N" should be sufficiently tight to prevent turning by the fingers. If not, remove nut and close the slotted end slightly with pliers.

Armature "A" should not rub or scrape on the armature stop nut screw. Do not, however, attempt to file the armature in case it does rub, since the armature is galvanized and the

filed spot would be liable to rust. It will be necessary to loosen the spring assembly screws to readjust the armature hinge spring when the armature is not centered on the stop nut screw.

Normal Position of Armature

The normal position of the armature "A" is in general against the armature stop nut "N", one or more springs usually being effective in holding the armature against the stop nut. Where there are no springs effective in holding the armature against the stop nut, the armature should normally take up a position slightly (no more than .005") away from the stop nut due to the normally slight hinge plate tension directed towards the pole face.

The armature travel or clearance "G" (See Fig. 9) between the stop pins on the armature "A", or the armature itself if no stop pins are provided, and the pole face "PF" varies for the different spring combinations, being smaller for those with the simpler spring combinations. As shown in Fig. 9, these clearances, together with the thickness gauges to be used are as follows,-

<u>Spring Combinations</u>	<u>Armature Travel</u>	<u>Gauge</u>
Nos. 1-2-10-11-15	.015"	67-A
" 3-7-8	.020"	67-B
" 4	.025"	67-C
" 5-6-18	.030"	67-D
" 9-12-13-14	.035"	67-E
" 19-20	.040"	67-F

With the gauge fully inserted (over the stop pins) the stop nut should be turned up (use Tool #231) until the gauge pulls in and out with only a veryslight friction. By this method the above clearance should be obtained with a variation with $\pm .002"$. In no case should the armature travel exceed $.045"$.

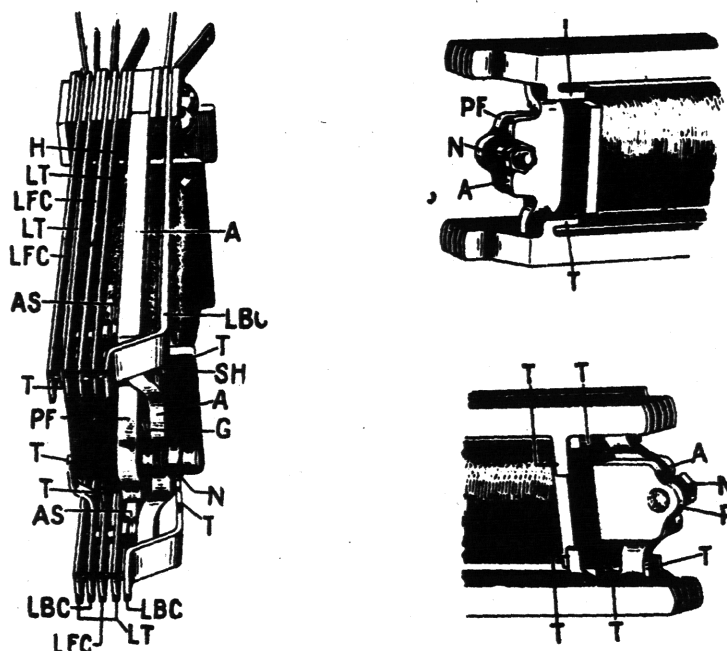


Fig. 9, "E" Type Relay - Armature in Normal Position.

Operated Position of Armature

Where stop pins are furnished on the armature, the stop pins should rest flush against the pole face "PF", when the armature is in a fully operated position.

Where no stop pins are employed, the armature "A" should rest flush against the pole face "PF" when the relay is in a fully operated position. Where the stop pins are omitted the relay is intended to have a low holding value or a slow release characteristic.

Springs

The proper contact separation, armature stud separation and spring follow as shown in Fig. 10, will normally obtain if the springs, except normally bent springs, are straight and the armature travel is as specified. Where normally bent springs similar to the long back contact springs "LBC" are involved, it may be necessary to bend the tangs to obtain these requirements. The tangs "T" on these latter springs are so designed as to permit such adjustments.

Contact separation, either in the normal or operated position, should not be less than .007 or .010 inch as specified for the different spring combinations (See Fig. 10). Long traveling springs "LT" normally closing back contacts should have a visible separation (not less than .005 inch) from the armature studs "AS" or if the relay has no springs normally effective in pressing the armature "A" all the way back to the stop nut "N" there should be a visible separation (not less than .005 inch) from the armature studs when the armature is moved all the way back to the stop nut by the finger. All long and all short front contact springs "LFC" and "SFC", should have a visible follow (not less than .005 inch) just after the contacts engage. The long back traveling springs "LBT" in spring combinations 6 and 12 (see Fig. 10) should have a follow of not less than .010 inch just after they break contact with the short back contact springs "SBC".

The tension of the springs should be adjusted by means of the adjusting tool #259. This tool should be applied to the springs only near their base and the tension should be regulated

by a slight turn either to the left or to the right. Care should be taken not to disturb the tension of adjacent springs and particularly not to bend the armature hinge plates "H".

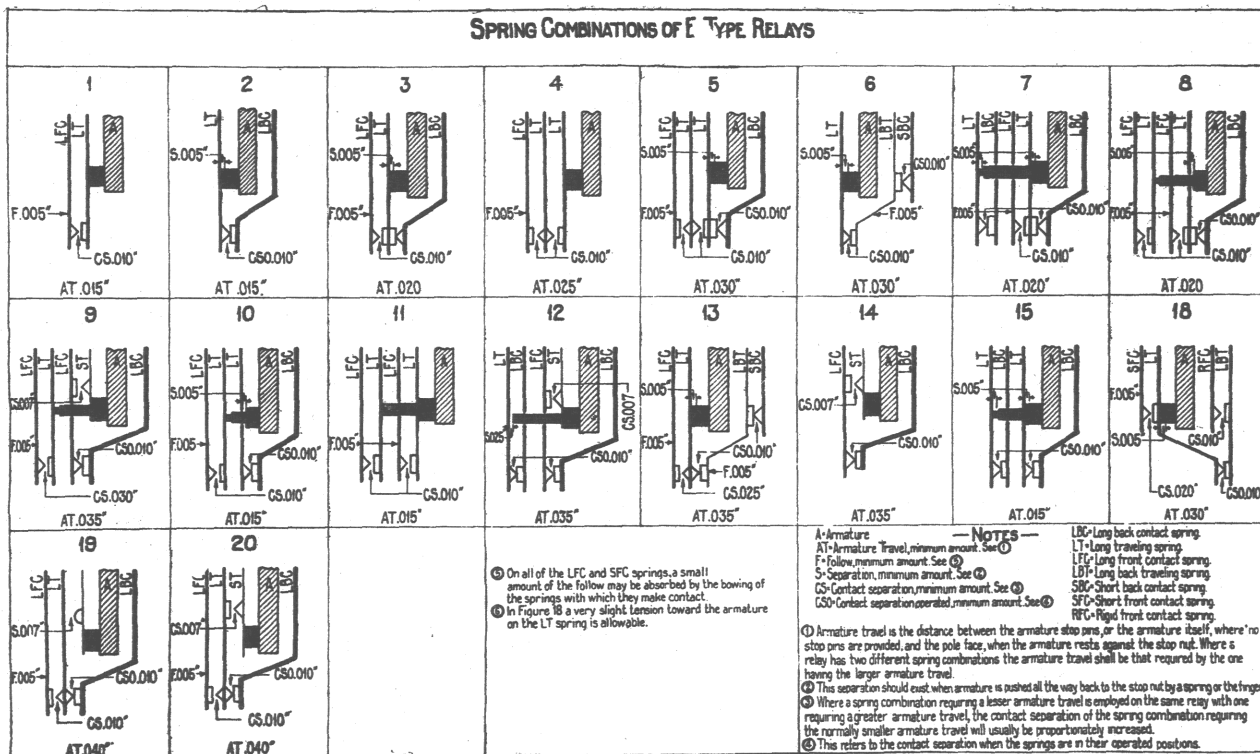


Fig. 10, "E" & "H" Type Relay Spring Combinations

All long and all short back contact springs "LBC" and "SBC" and all short rigid front contact springs "RFC" should be firmly tensioned against the spool head "SH".

All long and all short front contact springs "LFC" and "SFC" normally not closing back contacts should be moderately tensioned against the spool head "SH".

All long traveling springs "LT" and all short traveling springs "ST" normally not closing back contacts, should be tensioned just enough to press the armature "A" all the way back to the stop nut "N" or should be given a greater tension as may be necessary to meet the electrical requirements.

All long traveling springs "LT" and all long front contact springs "LFC" normally closing back contacts should be given as much tension toward the armature "A" as the electrical requirements will permit, but tensioning so as to cause excessive bowing should be avoided.

The long back traveling spring "LBT" in spring combination 18 (see Fig. 10) should be tensioned so that the long traveling spring "LT" will exert no pressure or only a very slight pressure on the armature stud.

As far as possible the tension on similar springs on a relay should be the same so as to insure uniform contact pressure except that the springs closing signaling circuits may be given a lesser tension than those closing talking circuits.

#87 Type of Relay

Special Features:

The #87 type of relay is a square shaped relay with a heavy armature. This relay is used as a ringing relay for signaling purposes. It is provided with two very thin contact springs normally not made which can be adjusted with a large follow. When ringing current is connected through the relay, the armature vibrates slightly due to the changing polarity of the current. The armature is made heavy so that it will not fully respond to the rapidly changing polarity of the magnetic flux.

The relay is so designed and assembled that the only parts needing adjustment are the contact springs which need to be adjusted with great care on account of their thinness. It is impracticable to attempt to tension or to straighten a bent spring while assembled to the relay on account of its inaccessibility. There is no adjustable back or front stop to adjust on this relay.

The relay is covered by an individual metal cover that is known as a cross-talk proof cover. The cover will intercept any magnetic flux from or to adjacent relays so as to prevent any interference in operation. Should the armature stick or bind, do not attempt to cause it to move freely by applying oil to the pivots.

See Figures 11 and 12 showing the #87 type of relay with the cover removed.

The armature of the #87 relay when energized, turns on its pivots so as to become aligned with the core. An armature stud, "AS" which is attached to the armature moves upward through a hole in the brass support for the lower contact spring or traveling spring, "TS" and pushes the "TS" upward so as to meet the "FCS" and move the "FCS" slightly away from the brass support. There should be a slight movement of the armature before the "TS" moves. When the relay is de-energized, the weight of the armature causes it to fall to its normal position.

The particular feature of this relay to be adjusted is the contact gap and follow of the contact springs. Should the relay frame be loose, it may be necessary to remove the relay from the mounting plate and fasten the frame by means of the screw in the center of the frame support "FS".

The contact springs should be in alignment in order that the contacts be centered. Screw "1" and the screw securing the "FCS" in place may be loosened to aid in aligning the springs.

Tools Required

Gauges

.010"

Tools

#35 Screwdriver

265 Contact burnisher

Crocus Cloth #00

Toothpicks

Carbon tetrachloride

Relay adjusting test set

Mechanical Requirements

Normal Position of Armature

The flexible springs should rest on their brass supports, when the armature is in its normal position and there should be approximately .010 inch clearance between the contacts.

The armature "A" should move freely, without binding

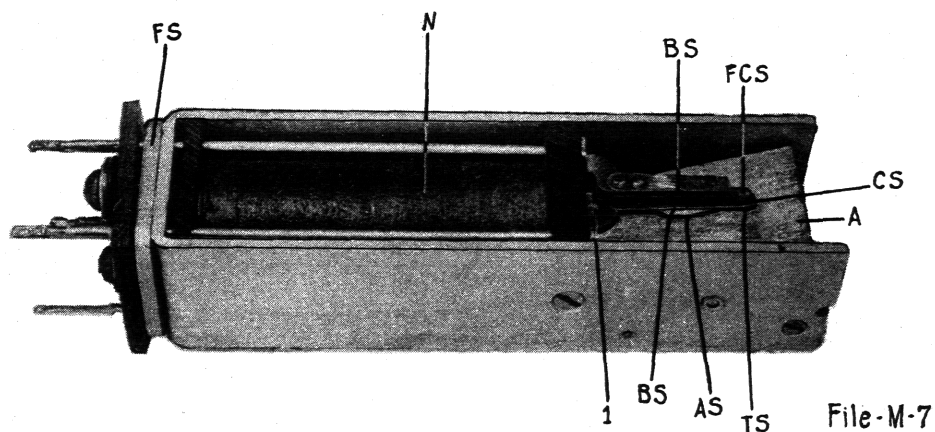


Fig.#11, #87 Type Relay - Armature in Normal Position.

Operated Position of Armature

Front contact spring "FCS" should be forced visibly (approximately .005 inch) away from its support when the armature "A" is in the operated position, as shown in Fig. 12.

The relay should then be adjusted to meet its electrical requirements and if necessary the location of the springs

may be changed by means of a small screw-driver at point "Y". When it is necessary to raise the spring upward the screw-driver should be placed under the brass support "BS" and never under the flexible spring.

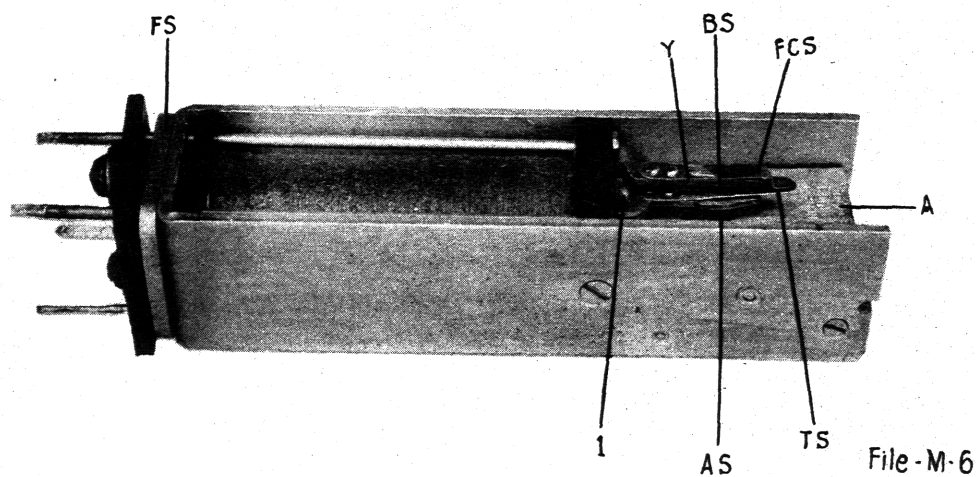


Fig. #12, #87 Type Relay - Armature in Operated Position

#114, 124 and 198 Types of Relay

Special Features:

The #114, 124 and 198 types of relays are all of the same general design. They are round type relays with an iron shell which serves as part of the magnetic circuit and also to make the relay cross-talk proof.

The #114 type is a plain relay (special types have copper sleeve on core).

The #124 type is provided with a copper collar around the armature end of the core to cause slow operation.

The #198 type is provided with a copper sleeve around the entire core to cause a slower operation than the #124 type.

These relays are usually used as ringing current tripping relays on trunk circuits and must carry the AC ringing current through a condenser such as is on a subscribers line without operating, but when the condenser is short-circuited by the removal of the receiver, it must operate on the ringing current or the silent period battery.

To prevent the relay from operating or vibrating on the ringing current, which may be alternating or pulsating, the armature is heavy and is controlled by a heavy retractile or retaining spring ("RS" of Figures 13 and 14). These relays are also sometimes provided with a copper collar or sleeve around the core. This makes possible a greater ringing current through the relay for a given amount of flux which causes the relay to be slow-acting.

The armature of this relay is mounted on pivot screws "APS" which are adjustable and held in place by lock nuts. The armature retaining spring "RS" is adjusted by loosening the retaining spring screw "RSS" and moving the retaining spring holder "RSH" to the left or right as required. Moving the holder to the left prevents the armature from operating on the low or non-operating current, by lengthening the leverage of the spring. Moving the holder to the right shortens the leverage and enables the armature to operate on the operating current.

On some relays of these types a follow spring is provided for the back contact.

Fig. 13 shows the 114, 124 and 198 types of relay with a front contact and without the follow spring on the back contact. Note that the armature is stencilled with a star indicating that all contacts on this particular relay are #1 metal.

Fig. 14 shows the same type relays without the front contact but with the follow spring back contact. This follow spring makes contact after the armature moves away from the back contact but breaks before the armature strikes the pole face. The tension or follow of this spring is adjusted by bending it near its fastening screw and can be removed for straightening by removing the fastening screw.

Tools Required:

Gauges

#41, .034"

#42, .015"

Tools

35, screwdriver

219, 5/16" wrench

220, 3/16" wrench

221, above three tools together

103, wrench

265, contact burnisher

crocus cloth #00

tooth picks

carbon tetrachloride

relay adjusting test set

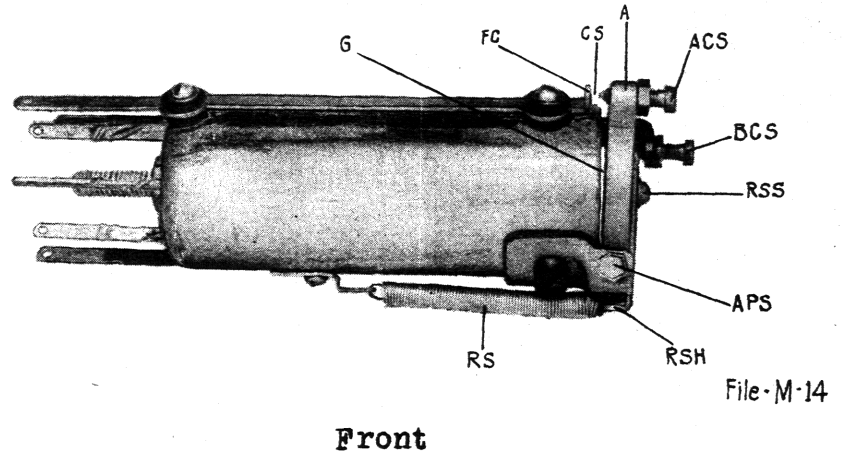
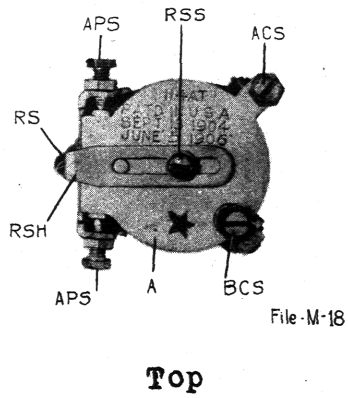


Fig. 13 #114 #124 and #198 type Relays (With front contact)

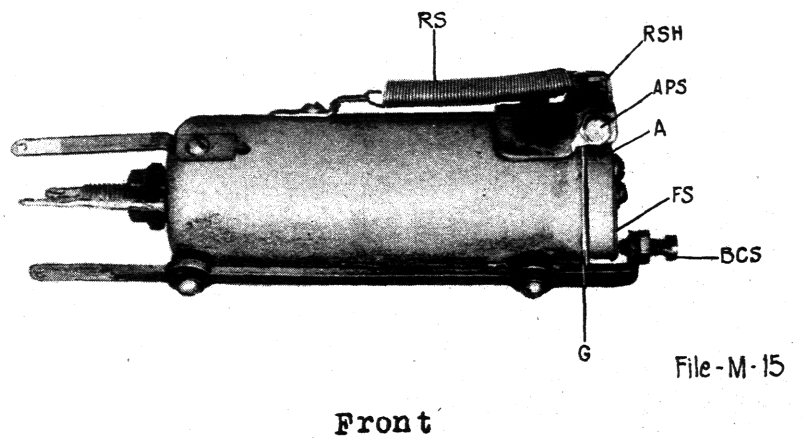
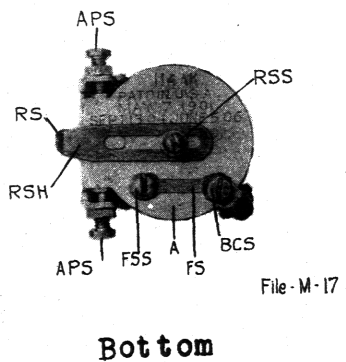


Fig. 14 #114 #124 and #198 type Relays (With follow spring)

Mechanical Requirements:

The armature should move freely; if necessary adjust by means of the armature pivot screws. If these screws are rounded off or burred, they should be changed.

Normal Position of Armature

Turn the back contact screw "BCS" Fig. 13, forward until it pushes the armature contact screw "ACS" against the front contact "FC"; then turn it back approximately one-half a turn and fasten the lock nut. This provides a clearance of approximately .010" between the armature contact screw and front contact when the relay is in the normal position.

When the #114 and #198 type relays Fig. 14, are used as machine ringing trip relays, the air gap or clearance between the armature "A" and the pole face should be obtained by means of the following gauges:

<u>Relay</u>	<u>Gauge</u>	<u>Air Gap</u>
#114	#41	.034"
#198	#42	.015"

With the gauge inserted between the follow contact on the armature and the back contact, turn the back stop screw "BCS" forward until the armature just touches the gauge; that is, the gauge should pull in and out with only a slight friction.

Adjust the relay to meet its electrical requirements by means of retractile spring which is fastened by the screw "RSS". Moving this spring away from the relay frame increases the tension on the armature "A". It also may be necessary to make slight re-adjustments in the locations of the contact screws in order to meet the electrical requirements.

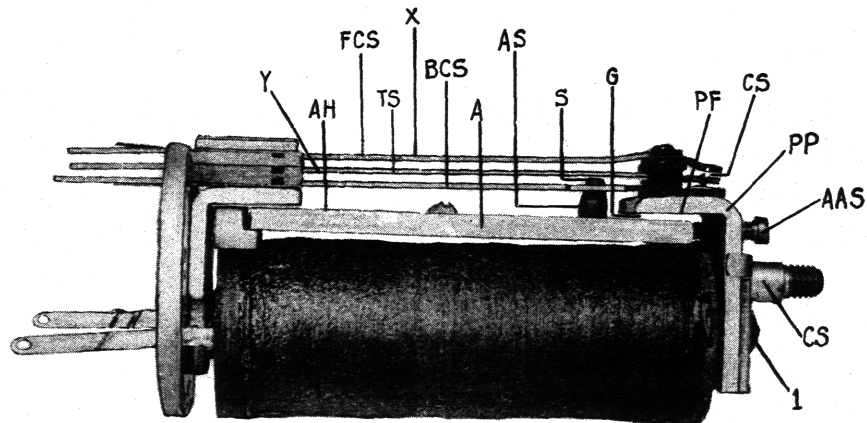
Operated Position of Armature

Turn the armature contact screw "ACS" Fig. 13, back and hold the armature "A" in an operated position against the pole face. After this turn the armature contact screw until it touches the front contact "FC"; then give it approximately a complete turn and fasten the lock nut. In no case, however, shall there be less than one-half a turn on the armature adjusting screw after it touches the front contact, since otherwise the armature may remain in an operated position after the flow of current through the relay has stopped. This clearance also insures a reliable front contact.

The principle of operation is as follows:- The relays are so designed that when the armature is pulled up the reluctance of the magnetic circuit is comparatively low so that the flux density is high. This is increased on some relays by the absence of stop-pins. When the circuit through the main winding is opened the strong magnetic field begins to decrease and in so doing, induces a voltage in the permanently closed electrical circuit causing a current to flow in it. This current sets up a magnetic field tending to reinforce the field already existing or decreasing. This causes the flux to die out slowly and the armature is held operated for a relatively long time. The magnitude of this effect is proportional to the amount of copper in the closed circuit; hence the copper tube is the most effective.

There is nothing in the appearance of these relays to indicate that they are provided with the copper collar or tube. The electrical requirements of individual relays will indicate slow operating test values for the relays designed for slow operation.

A round cover is provided for individual relays which is held in place by a nut on the cover stud "CS". The cover should not be forced in place. If the cover does not fit properly, the location of the cover stud "CS" should be changed by loosening screw #1. Relay cover nuts should never be fastened with a tool of any kind and care should be taken not to use the cover itself as a lever in order to fasten the nut. The nuts should be tightened with the fingers.



File-M-16

Fig. 15 #149, 162 & 178 types of Relays (Without Cover)

Tools Required:

Gauges

.015"

.020"

Tools

50, spring bender

35, screwdriver

219, 5/16" wrench

220, 3/16" wrench

221, above three tools together

265, contact burnisher

crocus cloth #00

tooth picks

carbon tetrachloride

relay adjusting test set

Mechanical Requirements:

Normal Position of Armature.

There should be a minimum clearance of .015" between the pole-piece and armature when the latter is against the stop screw, if the relay has make-break springs; .020" if the relay has break-make springs and .015" if the relay has break springs only.

This may be obtained by adjusting the location of the armature adjusting screw "AAS". In no case should the travel or clearance exceed .030 inch.

The armature hinge plate "AH" should not be buckled; that is, if the traveling springs "TS" are raised away from the armature studs "AS" there should be practically no pressure exerted on the armature "A", which would tend to hold it against the adjusting screw "AAS". In no case shall the hinge plate be buckled or raised away from the armature more than one-thirty-second of an inch.

The pole piece "PP" should be parallel to the face of the armature "A". In some cases the location of the pole piece may be changed as it is held in position by screw "1".

Operated Position of Armature.

Where no stop-pins are provided, the armature should rest flush against the pole-piece at both sides. In such cases the relay has a "slow release" characteristic.

Springs

The traveling spring "TS" when in the normal position should not rest against the armature stud "AS". It should be possible to move the armature slightly (approximately .005 inch) at point "H" without moving the traveling spring.

Adjust the relay to meet its electrical requirements and in case it is necessary to change the adjustment of the traveling springs "TS" it should be done with tool No. 50 at point "Y". Care should be exercised after the traveling spring has been adjusted to see that it does not rest on the armature stud "AS".

There should be a minimum clearance of .010" between the contacts on the springs when the relay is in the operated position.

When the front contact springs "FCS" are provided with a brass support the flexible part of the springs should rest on the brass support over its entire length when the relay is in the normal position. When the relay is operated the flexible front springs should raise slightly away from the brass support so as to insure sufficient contact pressure. If it is necessary to bend the front contact springs it should be done at point "X".

Where make-break springs are used the short traveling springs should rest on the armature studs and the front contact springs should be firmly tensioned, without bowing or having the spring bent.

Where break-make springs are used the traveling springs "TS" should be firmly tensioned.

Care should be taken to have the spring tensions and armature stud separation equal on both sets of springs, when two sets are provided on one relay.

#177 and #203 Type Relays

Special Features:

The 177 and 203 relays are of the same general design the only difference being that the 177 type is provided with short terminals for wiring inside an individual cover while the 203 type is provided with long terminals and arranged to mount on the mounting plate with the wiring on the reverse side of the plate.

These relays are called "polarized relays" and are designed to operate only when the current through the windings is poled properly. If the winding is connected into the circuit one way and current is allowed to flow through the relay the armature will operate, but if the current is reversed, the armature will not operate.

This type of polarized relay has two windings connected in series, the two cores being connected by a yoke. A permanent magnet "PM" is so mounted on the frame that one of its poles is directly opposite the armature (assuming the relay to be mounted vertically). The armature is pivoted at its center to the frame. Let us call the end of the core of one coil Pole A, and that of the other, Pole B, and assume the pole of the magnet next to the armature is a north pole. If current is passed thru the coils in one direction, "A" will become a north pole and "B" a south pole. The north pole of the permanent magnet will oppose the field between "A" and the armature since these fields will be in opposite directions. Hence the field above "A" will be weak. But between "B" and the armature the field due to pole "B" and the pole of the permanent magnet will

be in the same direction, thus aiding each other and producing a strong field. This will cause the armature to be pulled toward pole "B". If, however, the current is reversed "B" will become a north pole and "A" a south pole which will reverse the conditions and the armature will be pulled toward pole "A".

The armature is held against the top core by the normal pull of the magnet and tension of the long traveling spring when a back contact spring is not provided.

Figure 16 shows a #203 type relay provided with a back contact spring "BCS" and one set of springs. Figure 17 shows a #203 relay without back contact springs and with two sets of contact springs.

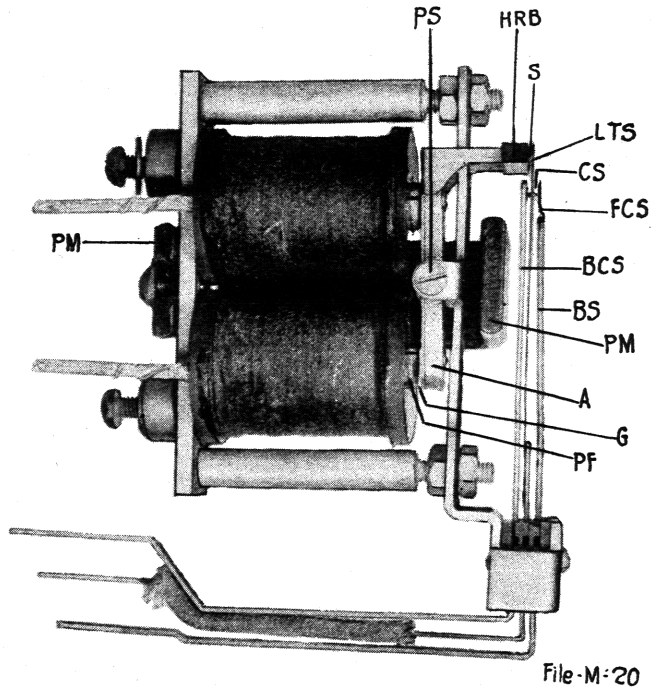
When two sets of contact springs are provided they should be tensioned equally.

Care should be taken to keep the hard rubber bridge "HRB" clean where the "LTS" rubs.

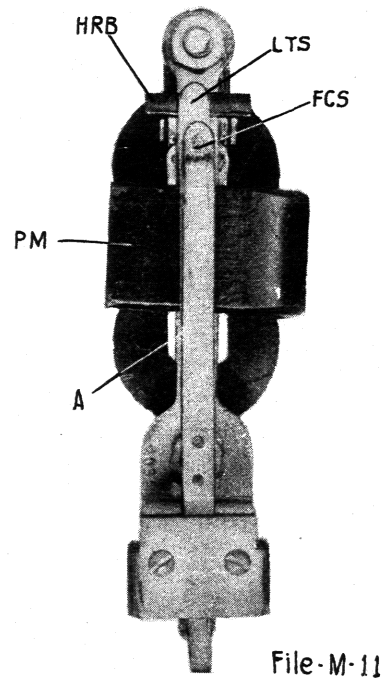
Individual covers are provided for these relays unless they are mounted with other relays without covers when a common cover for all relays on the plate is furnished.

The armature should move freely in its bearings.

The adjusting nuts at either end of the armature support plate should be set up tightly.



Side



Front

Fig. 16 #177 & 203 types of relays (with both front and back contact springs)

Tools Required:

Gauges

#42, .015"

Tools

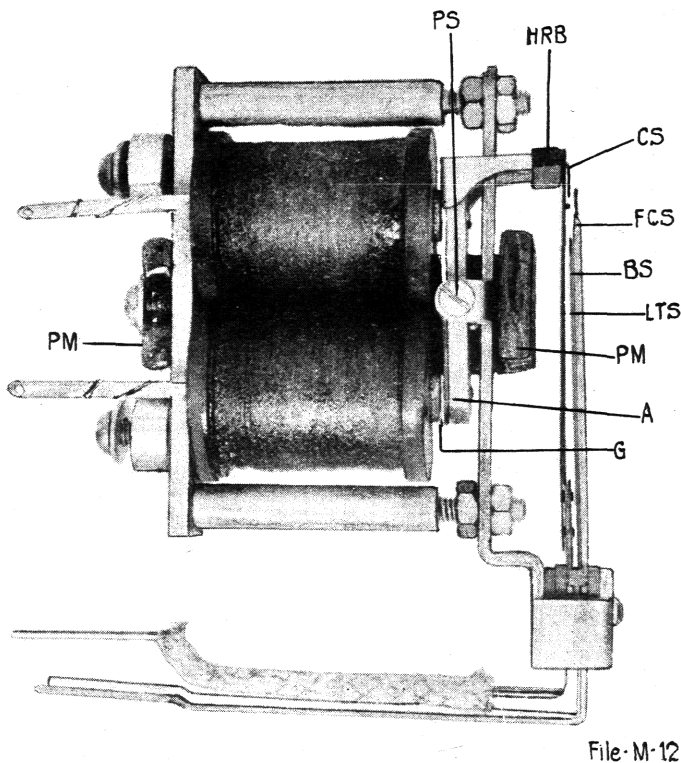
98, spring bender
208, wrench
35, screw driver
265, contact burnisher
crocus cloth #00
tooth picks
carbon tetrachloride
relay adjusting test set

Mechanical Requirements:

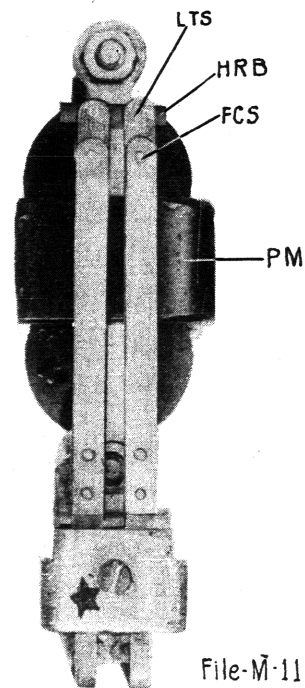
Normal Position of Armature.

The armature "A" in its normal position should rest against the pole face of the upper coil; (or coil near the contact end of the spring.)

There should be a perceptible (.005") separation between the hard rubber bridge "HRB" on the armature arm and the long traveling spring "LTS" when a back contact spring "BCS" is provided.



Side



Front

Fig. 17 #177 & 203 types of Relays (with two front contacts)

Operated Position of Armature

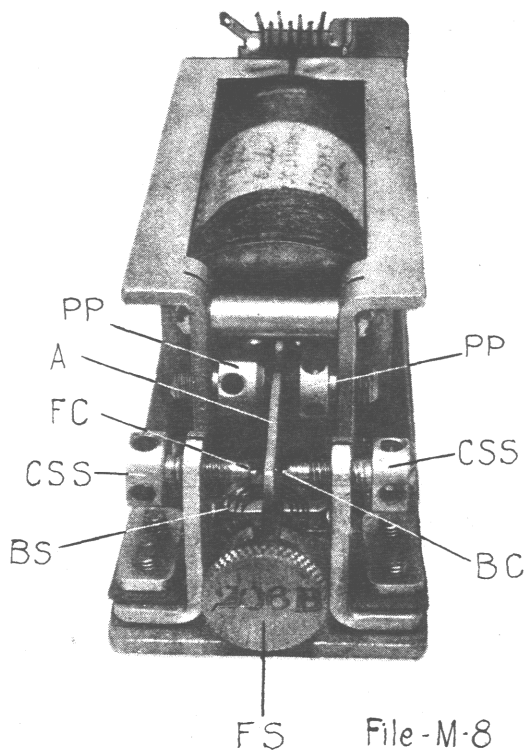
Armature travel (or separation between armature and pole face of Lower coil) should be from .015" to .020". This may be

obtained by means of the thickness gauge #42. With this gauge inserted between the armature and the lower pole face, adjust the nuts "N" until the gauge can be pulled in and out with only a very slight friction. Usually only the lower nuts "N" need be adjusted. The long traveling spring "LTS" should be tensioned against the back contact spring "BCS", as found necessary for current requirements. The front contact separation should be approximately .010". The flexible front contact spring "FCS" should be forced visibly (.005") away from its support when the armature is in its operated position. In its fully operated position, the stop pin on the lower end of armature should rest flush against the pole face of the lower coil.

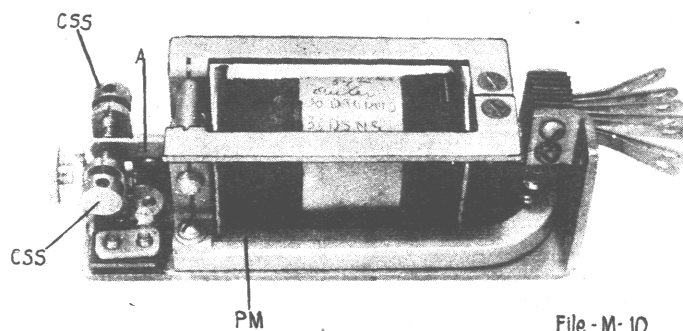
#206 Type Relay.

Special Features.

The #206 relay (Fig. #18) is a polarized relay with one coil and a small movable core. The core passes through the coil. One end is fastened to the base in the rear of the relay and the front end called the armature, is provided with contacts and is movable from right to left. A permanent magnet "PM" is mounted around the lower part of the coil, the ends of which are extended upwards in front of the coil. Two adjustable pole pieces are screwed into the uprights opposite the armature. The relay is adjusted by turning the finger screw "FS" to which the biasing spring "BS" is attached so as to cause more or less tension to be exerted against the movement of the armature.



Front



Side View

Fig. #18 #206 type Relay (without cover)

The permanent magnet causes the pole pieces to be polarized, one a north pole and one a south pole. The armature is normally very close to the right pole piece and therefore its polarity is opposite that of the pole piece. When a current is allowed to pass through the coil, in the proper direction to cause the armature to operate, the movable core of which the armature is a part, is magnetized so that the front end is the same polarity as the pole piece near which it is resting, but much stronger. The armature is then attracted by the left pole piece and repelled by the right pole piece and being movable moves against the tension of the biasing spring toward the left pole piece until it makes contact with the front contact "RC". Should the current be connected so as to magnetize the core in the opposite direction, the armature will be poled oppositely from the polarity of the right pole piece, which it is resting near, and will be held in its place. No movement of the armature takes place when the armature is of the same polarity as the left pole piece.

The #206 type relay is provided with an individual cover which entirely encloses the relay and is removed only for inspection or test purposes.

Tools Required:

Gauges

.004"

Tools

212, adjusting tool

35, screwdriver

Tools

265, contact burnisher
 crocus cloth #00
 tooth picks
 carbon tetrachloride
 relay adjusting test set

Mechanical Adjustments.

Normal Position of Armature.

The normal position of the armature is against the right hand pole piece "PP" and the back contact "BC". To properly position the pole pieces and contact stud screws the following routine should be followed.

1. The biasing spring "BS" should be moved away from the armature and both pole pieces "PP" should be moved at least $1/32$ " away from the armature.

2. The contacts should then be so located (by turning the contact stud screws) "CSS" that the armature, in its free position appears to be centrally located between them and has an allowable travel from back contact, to front contact, of .004" measured by a gauge.

3. The pole pieces should then be moved up until the armature will just remain against either contact when placed there.

4. The biasing spring should then be moved against the armature until the armature just makes on the right hand (back) contact.

5. Adjustments to meet the electrical requirements are made by means of the biasing spring.

Contact stud screws "CSS" should be sufficiently tight to prevent turning by fingers. If not, remove screw and close the slotted post slightly with pliers.

Tool #212 should be used in changing the position of pole pieces and contact stud screws.

#207 Type Relay.

Special Features.

The #207 type relay is used in machine switching systems as a "stepping" relay in the sender circuits. It is one of the most important relays as it controls practically all selecting operations. The #207 relay must operate and release once for each pulse of current sent by the selectors at the rate of about 30 per second. This circuit requirement makes it necessary for the stepping relay to operate and release very fast.

The stepping relay has a double coil winding. The armature has a delicate retractile spring, the tension of which is adjusted by means of a screw. This spring is not mounted rigidly on the armature, but is free to turn, thus preventing any torsion in the spring. The stepping relay has only a front contact, which is mounted on a heavy spring in such a way that the contact gap can be adjusted by means of an adjusting screw. The contact gap should be .004". The armature gap should be about .015". This allows an air gap of .011" when the relay is in the operated position, which causes the armature to fall back quickly when the circuit is opened. When the relay releases the core retains some residual magnetism, which makes the relay pull up quickly when the circuit is again closed.

The armature should be located in front of the two cores so as to cover the two cores and allow the armature retaining spring to pass through the hole in the back stop support, with as

much clearance as possible. This location may be secured by adjusting the armature pivot screws "APS" (Figure #19).

The armature should move freely with a little side play which will prevent binding due to temperature changes. The pivot screws should be changed if worn or rounded at the points. The pin "P" holding the armature retractile spring "ARS" should be free to turn in the armature and should be straightened if bent enough to cause binding.

The front contact should be centered with the armature contact if necessary by changing the location of the contact spring. This can be changed by loosening the assembly screws holding the front contact to the base or by bending the contact spring.

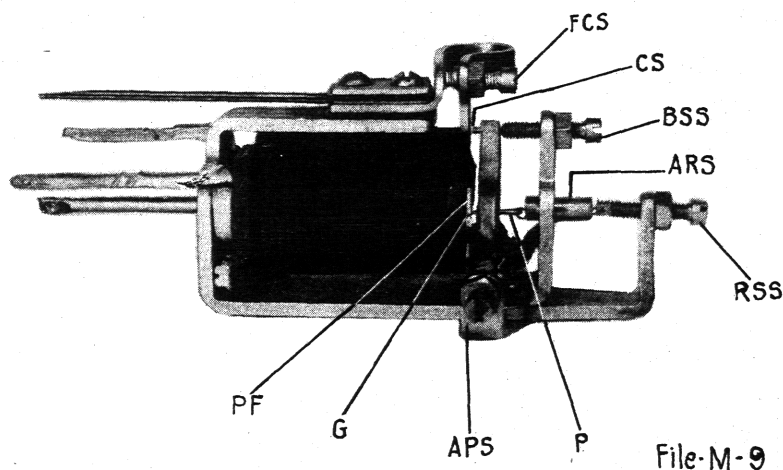


Fig. 19. #207 Type Relay (side view).

The #207 type relay is not furnished with a cover but is usually mounted in a case with other relays.

The contacts of the #207 type relay should be kept clean and should be cleaned each time a routine inspection or test of the relay is made. The relay should be adjusted very carefully and operated many times after a change in adjustment

is made, so that any change in location of the retractile spring, which may later affect the relay may be detected and corrected. The wire connecting the armature to the base should be dressed to its final location before the electrical adjustment is made and not disturbed after the relay has once been adjusted.

All locknuts should be tightened before the electrical test is made.

Tools Required:

Gauges

#42, .015"

Tools

35, screwdriver
219, 5/16" wrench
220, 3/16" wrench
221, above three tools together
208, wrench
265, contact burnisher
crocus cloth #00
tooth picks
carbon tetrachloride
relay adjusting test set

Mechanical Requirements.

Normal Position of Armature:

Turn the back stop screw "BSS" forward, the front contact screw "FCS" having been turned back sufficiently, until the armature "A" only slightly binds at the pole face "PF". Then turn the back stop screw "BSS" back one and one-half turns and set

the locknut. This will insure a minimum clearance of .013" between the armature in its normal position and the pole face.

The normal position of the armature may also be obtained by means of the thickness gauge #42. With the gauge inserted between the armature "A" and the pole face "PF", turn the back stop screw "BSS" forward until the armature just touches the gauge; that is, so that the gauge can be pushed in and out with only a slight friction.

Operated Position of Armature:

Turn the front contact screw "FCS" back until the front contact just touches the contact on the armature. Then turn the front contact screw forward one-quarter turn and set the locknut. This will insure a contact separation of .004" approximately.

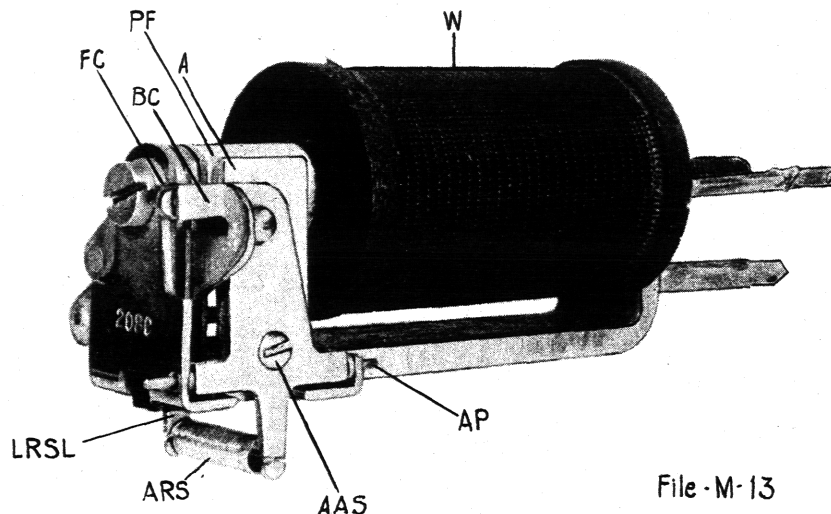
Adjust the relay to meet its electrical requirements by means of the armature retractile spring "ARS", controlled by the retractile spring screw "RSS".

#208 Type Relay.

Special Features:

The #208 type relay is used as a counting relay in sender circuits and in other circuits which require a very fast relay, both in operating and releasing. This relay was especially designed to meet these requirements. It has a small armature mounted on the side of the pole face which is an extension of the core. The armature is pivoted through its horizontal centre and held in the non-operated position by means of a retractile spring. It has two contacts, one front and one back. The contacts are mounted on the front of the relay, thus allowing the relay to be made very rigid. The contact gap is very short, being only about .004". This makes a very short armature travel. The armature air gap is about .018", so that when the armature is pulled up there is still a comparatively wide air gap left. This feature makes the relay release very quickly when the current has been cut off.

Counting relays are mounted in one large case with other relays of the sender circuit, the counting relays for three senders being mounted in a single case. They do not have any covers.



File-M-13

Fig. 20. #208 Type Relay (side view)

When the #208 relays are under test or inspection they should be inspected for worn or bent armature pins. Should it be necessary to remove the pin the armature retractile spring "ARS" should first be removed from the slot in the right hand lug and the armature assembly screw "AAS" loosened. The pin may then be drawn out from the armature and supporting holes by grasping the front end with pliers. The hand or a piece of paper should be held under the relay to catch the two bushings or washers that may drop out when the pin is withdrawn. When the pin is replaced it should slip in easily and not be forced.

The armature retractile spring "ARS" should be firmly fastened or tensioned so that it will not slip out of the slots on its supporting lugs.

The general structure of this relay is such that it should not be necessary except at long intervals to readjust the location of the front contact "FC" or the back contact "BC".

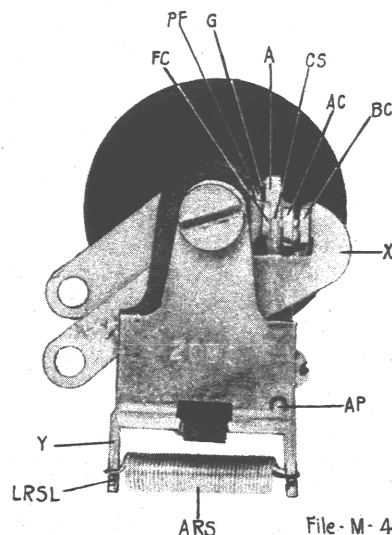


Fig. 21. #208 Type Relay - front view.

Tools Required:

Gauges

73 - A .018"-.022"

73 - B .007"-.008"

74 - A .003", .004", .005" & .006"

Tools

264 lug bender

35 screwdriver

265 contact burnisher

crocus cloth #00

tooth picks

carbon tetrachloride

relay adjusting test set

Mechanical Requirements:

Normal Position of Armature:

The air gap "G" - that is, the clearance between the armature "A" when it rests against the back contact "BC" and the pole face "PF", together with the thickness gauge to be used, is shown in the following table:

<u>Relay</u>	<u>Air Gap</u>	<u>Thickness Gauge</u>
#208(B,C,E,G,)	M, N, S	{ .022" Max. { .018" Min.
#208(H,J,K)		
	L	{ .0075" Max. { .007" Min.
		73 - A
		73 - B

To obtain the proper air gap adjust the back contact "BC" by means of the lug bender applied at the point "X" until the thickness gauge pulls in and out with only a very slight friction.

Operated Position of Armature:

The contact separation between the contact on the armature "A" and the front contact "FC" together with the thickness gauge to be used is shown in the following table:

<u>Relay</u>	<u>Air Gap</u>	<u>Thickness Gauge</u>
#208 All codes	.004"	74 - A

To obtain this contact separation adjust the front contact "FC" by means of a screw driver and long nose pliers until the thickness gauge pulls in and out with only a very slight friction.

Adjust the relay to meet the electrical requirements by means of the armature retractile spring "ARS", controlled by the left hand retractile spring lug "LRSL". To bend this lug apply the lug bender at the point "Y". Never bend the right hand retractile spring lug because this tends to distort the armature.

MESSAGE REGISTERS.

The current required for the operation of line message registers is so much in excess of that required for relays that the current flow test set designed for use in connection with relays is not suitable for use with message registers.

The reliability of this piece of apparatus so directly concerns the subscriber that both its operating and non-operating features are of unusual importance. These depend upon its accurate adjustment which in turn requires extreme care and the use of a somewhat complicated test set.

All the registers are carefull adjusted and tested by the installer and should maintain their adjustment for a considerable period. Where any trouble is experienced which would seem to require readjustment of the register, the register should be removed and replaced by a spare register - that is, no attempt to readjust the line registers should be made by the maintenance force. Parts requiring cleaning on account of sticking should be cleaned with chemically pure carbon tetrachloride as described for contact cleaning.

ELECTRICAL REQUIREMENTS.

General.

In order to make certain that the electrical characteristics of a relay - that is, the number of turns, reluctance of magnetic circuit, etc., are correct, and also to check the mechanical adjustments, as made in accordance with the requirements set up in the preceding pages - that is, spring tension, etc., the specified current for operate, non-operate, hold, or release as the case may be, should be caused to flow through the relay, and the closure or opening of the contacts observed either by sight or preferably by the operation of some other relay or signal included in the circuits of the contacts.

Each relay will have a set of testing values and adjusting values. The adjusting values will be the predetermined design values, while the testing values in general will be some values less severe, depending upon the amount of margin between the designed values and the most severe circuit requirements.

These testing and adjusting values are specified for each relay for each circuit by the Western Electric Company on its method of operation sheets.

When a relay is to be checked or adjusted, the circuit with which it is associated should be taken out of service in accordance with the "Instructions for Taking Equipment Out of Service." Relays which have been adjusted on account of a reported trouble should be referred to the switchman before this equipment is again placed in service.

In the Method of Operation Sheets the tester is instructed to do the following:

- Toothpick certain sequence switch springs;
- Toothpick certain relay contacts open or closed;
- Block relays operated or to prevent operation;
- Attach the test clip to relay contact springs;
- Brakeplate a sequence switch in a particular position.

A piece of thin fibre or micarta should be used to "toothpick" the sequence switch springs.

In "toothpicking" any relay contacts open, an ordinary flattened toothpick is used to separate the contact springs so that they do not make. The toothpick should not be placed on or near the platinum contacts, as it has been found that pieces of wood fibre or duct are sometimes left on the contacts, subsequently causing trouble. Paper or similar material should not be used to separate the contact springs.

The contacts of "E" type relays may be separated by inserting a toothpick between the spoolhead and the spring itself. The contacts of round type relays may be separated by inserting the toothpick between the springs back of the contacts.

The term "block relay operated" means to operate the relay by hand and then wedge the armature so that it cannot release. A relay may also be blocked to prevent its operation. Relays of the "A" or "E" type are blocked by placing a small metal clip (Tool #136), made especially for this purpose, between the movable armature and the core to prevent operation, or between the armature and the stop nut to prevent release. The #149 type relays are blocked by inserting a tapered piece of fibre between the spool and side armature to prevent release, or between the armature and

core to prevent operation. All wedges or toothpicks must be removed from the relays before the equipment is placed in service.

When a sequence switch is to be brakeplated the standard brakeplate tool should be inserted between the magnet and the driven disc before turning the switch to the indicated position. The brakeplate should be removed before the switch is returned to the normal position.

In the relay adjusting instructions the top set of springs on a flat type relay is designated the "T" springs and the bottom set the "B" springs. A set of springs is called a "pile up." The terminals of the relay are designated as lugs 1, 2, 3, etc., counting from left to right, looking at the relay from the rear or wiring side. For example - lug 3-B indicates that the lug is the third from the left on the bottom set, and lug T-4 is the fourth from the left on the top set.

The code number or the "D" specification number of a flat type relay is usually stamped on the top outer spring. The resistance of the winding is stamped either on the spoolhead or on the face of the relay core at the end nearest the mounting plate.

In the majority of cases relay contacts are of No. 1 contact metal, an alloy having a slightly yellowish tinge. Under certain circuit conditions, however, the use of platinum is deemed advisable and in order that springs so equipped may be readily identified a star is stamped on the spring near the contact. Care should be taken in replacing springs to insure that a spring marked with a star is always replaced by one similarly marked.

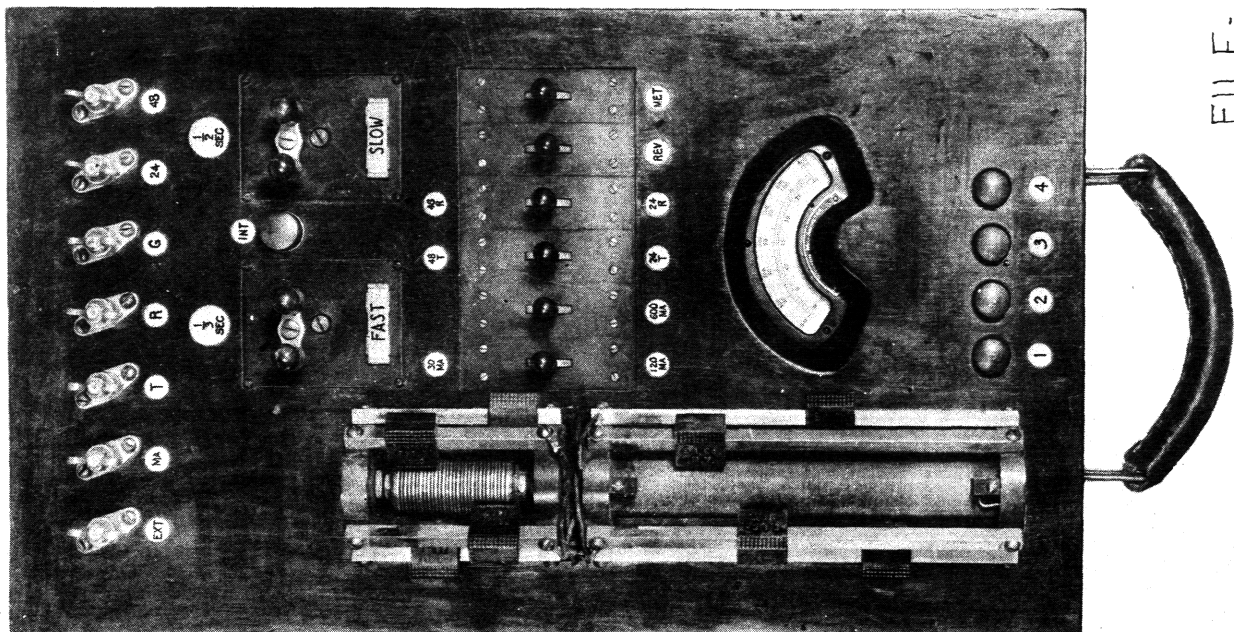
When No. 1 contact metal is used it is not so important that the replaced spring is so equipped, and a platinum contact spring may be substituted if no other is available.

RELAY ADJUSTING TEST SET.

General Description.

The relay adjusting test set is designed for use in checking and adjusting relays and other apparatus for which current adjustments are specified. It is made up in portable form so that it can be placed conveniently near any apparatus which is to be checked or adjusted. A picture of the top of the test set is shown in Fig. #22.

A three-scale milliammeter is provided for measuring current flow, the scales being for 30, 120 and 600 milli-amperes. Three keys, designated "30 MA", "120 MA" and "600 MA" are used for cutting into the circuit the corresponding milliammeter scales.



FILE-S-1

Fig. #22. Relay Adjusting Test Set (top view)

For controlling the current flow there are two units of variable resistance each of which has four slide contacts, which are used with the numbered push-button keys. In addition to being numbered these keys are designated respectively as follows:

"O" = Operating

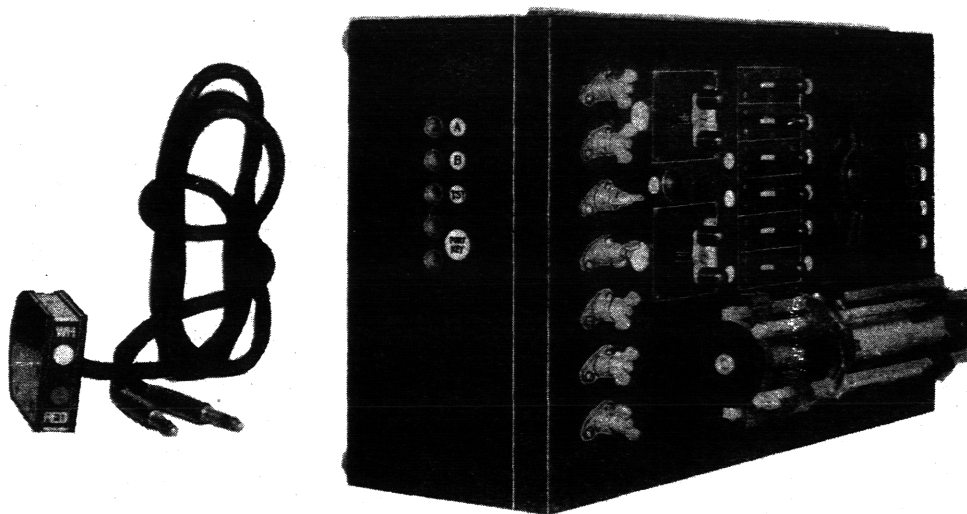
"NO" = Non-operating

"H" = Hold

"R" = Release

One resistance unit is a short drum with an assembly of circular contacts which are connected to spool resistance inside the test set, giving a range of 0 to 50,000 ohms. The other unit is a long drum wound closely with bare wire, giving a range of 0 to 1800 ohms.

By means of the slide contacts it is possible to cut in- to the circuit a different amount of resistance for each of the push-button keys, although there are few relays for which more than two current requirements are specified.



V-1-A

FILE V-1

Fig. #23. Relay Adjusting Test Set
(with portable keys)

(End View)

For convenience in testing, a portable key, shown on Figure #23, having two push-buttons is furnished with the test set. The key is equipped with accord and two plugs for connecting it to the jacks marked "Port" Key of the test set. Either plug may be placed in either jack. The buttons on the portable key when depressed cause the same circuit conditions as would the "O" and "NO" keys on the test set. The "NO" button of the portable key may be used as an "N" or "R" key by adjusting the #2 slides to the "H" or "R" requirements.

Jacks "A" and "B" are provided for the purpose of connecting the test set by means of patching cords to battery supply jacks "A" and "B" on the various frames. Binding posts "24V", "48V" and "G" are provided so that connections to battery and ground can be made by cross-connecting wire where battery supply jacks are not convenient.

Jack "TST" is used in connecting the test set to the apparatus which is to be adjusted. Connections may be made by means of a cord with plug for jack "A" and clips on tip and ring conductors for attaching to apparatus. When the apparatus is permanently wired to a jack, a double ended cord may be used. Binding posts "T" and "R" may be used for connecting the test set to the apparatus by means of cross-connecting wire when not convenient to use jack "TST".

For testing relays which are intended to be slow in releasing two Spl. #50-C keys are furnished, one designated "1/3 Sec." (fast) and the other "1/2 Sec." (slow). While these keys are being used, key "INT" must be operated in order to make the interrupter contacts of the Spl. #50-C keys effective. In general, slow release

relays should not release on $1/3$ second impulses but should release on $1/2$ second impulses by turning the handle around clock-wise to the stop and then letting go the handle. This operation winds a coiled spring which, when the handle is released, returns the handle to its normal position and at the same time actuates a cam which makes and breaks a pair of contact springs several times while the key is returning to normal. On the " $1/3$ Sec." key the cam cuttings are such that the make and break periods are equal and of approximately $1/3$ second duration. On the " $1/2$ Sec." key the periods of make and break are also equal but are of " $1/2$ Sec." duration.

Key "INT" must be in its normal position when the Spl. #50-C keys are not used, in order to short circuit the normally open contacts of the Spl. #50-C keys.

In addition to the apparatus already mentioned the test set has six keys which are designated as follows:

"24V (T)", "48V (T)", "REV", "24V (R)", "48V (R)" and "Met." They are used in supplying to apparatus under test the required conditions as to battery, ground and metallic circuit.

The binding posts designated "EXT" and "MA" may be used to connect any milammeter to the circuit if the milammeter in the set be defective or removed. It will be necessary to disconnect the wiring at the milammeter in the set when the external milammeter is used.

Both the tip and ring circuits in the relay test set are provided with $1/2$ ampere fuses. These fuses are located in the box on the inside of the cover. There is nothing to indicate that

these fuses have blown should an excessive amount of current cause them to open. If the test set fails to operate properly the fuses should be inspected.

Method of Operation:

It will be found that the operating windings of relays are wired into the circuits in four different ways, as follows:

1. Relay has one winding with one terminal connected to battery. The test set will be required to furnish ground through the variable resistance and milammeter to the other winding terminal.
2. Relay has one winding with one terminal connected to ground. The test set will be required to furnish battery through the variable resistance and milammeter to the other winding terminal.
3. Relay has one winding with neither terminal connected to battery or ground. The test set will be required to furnish ground to one winding terminal and battery through the variable resistance and milammeter to the other winding terminal. Care should be taken to have the polarity of testing current the same as that received by the relay when in use.
4. Relay has two windings with one terminal of one winding connected to ground, and one terminal of the other winding connected to battery. If the relay is to be adjusted with the windings in series the test set will be required to connect the variable resistance and milammeter between the two winding terminals which are not connected to battery or ground.

The manner in which each relay is "picked up" or connected to the test set is described in the Western Electric Company's Method of Operation Sheets.

With the "24V (T)", "48V (T)", "REV", "24V (R)", "48V (R)" and "MET" keys normal, and one of the milammeter keys of the test set operated, the tip clip is connected through the variable resistance and milammeter to ground and the ring clip directly to ground, when any of the adjusting keys (O, NO, H or R) is depressed. Therefore the tip clip alone will be used except when both battery and ground are to be supplied from the test set. The ring clip is used to supply battery or ground to a relay which is not permanently connected to either battery or ground.

For 48V battery on the tip, operate "48V (T)" key

" 24V	"	"	"	"	"	"24V (T)"	"
" Ground	"	"	"	"	"	no keys.	
" 48V battery on the ring,	"				"	"48V (R)"	"
" 24V	"	"	"	"	"	"24V (R)"	"
" Ground	"	"	"	"	"	no keys.	

For metallic circuit from test set, operate "MET" key.

It will not be necessary to operate any two of these keys at the same time.

The "REV" key is used to reverse the direction of current flow in the milammeter should the needle move to the left instead of to the right when any of the adjusting keys are depressed.

In order to avoid passing an excessive amount of current through the milammeter when using the test set, proceed as follows:

1. Before connecting up the test set -
 - (a) See that all keys are in their normal positions.
 - (b) Move all resistance slides so as to cut in all of the resistances.
2. By means of cords with clips attached -
 - (a) Connect the "24V" binding post to a convenient punching supplied with 24-volt battery.
 - (b) Connect the "G" binding post to a convenient ground.
3. Make connections to the relay to be tested, as specified for the particular relay.
4. Operate the "24V (T)", "24V (R)" or "MET" key as specified for the particular relay.
5. Operate the "600 MA" key and, with the "O" key depressed adjust the #1 slides (see "NOTE" below) so that the reading of the millammeter comes within the capacity of the scale to be used for the particular relay under test.

If direction of current flow is wrong, as indicated by the movement of the millammeter needle to the left instead of to the right, operate the "REV" key.

NOTE:

The short drum has a total resistance of 50,000 ohms; it is an assembly of circular contacts which are connected to spool resistance coils ranging from 10,000 ohms down to 1,000 ohms as follows:

1st coil	-	10,000	ohms	
2nd	"	8,000	"	
3rd	"	4,000	"	
4th	"	2,000	"	
5th	"	2,000	"	
Remaining 24 coils	-	1,000	"	each

The long drum is a slide wire resistance of 1800 ohms.

When any one of the push-button keys ("O", "NO", "H" or "R") is depressed and the slides are set as per 1 (b), all of the resistance in both drums is in series with the relay under test and the millammeter. The proper current flow is obtained by cutting out resistance first by means of #1 slide on the short drum, and then by #1 slide on the long drum. In many cases it will be necessary to cut out all the resistance of the short drum.

6. Restore the "600MA" key and operate the proper "MA" key.
7. With the "O" key depressed, adjust the #1 slides until the exact operating current as specified for the relay under test is obtained.
8. When a non-operating current is specified, hold the "NO" key depressed and adjust the #2 slides until the exact non-operating current is obtained.
9. Depress and release the "O" and "NO" keys alternately several times, observing the action of the relay.

NOTE:

For convenience in testing, a portable key having two push-buttons is furnished with the test set. The key is equipped with a cord and two plugs for connecting to jacks "PORT" of the test set. The buttons on the portable key close the same circuits as the "O" and "NO" buttons on the test set. The "NO" button of the portable key can be used as an "H" or "R" key by adjusting the #2 slides to the "H" or "R" requirements.

10. If relay does not respond properly, adjust it to meet the current requirements in accordance with data for the particular relay.

Holding Current:

When a holding current is specified, proceed as follows:

After adjusting the #1 and #2 slides to the "O" and "NO" requirements, depress the "H" key and by means of the #3 slides obtain the holding current specified.

To test the relay -

- (a) Depress the "O" key.
- (b) If relay operates properly, depress the "H" key while the "O" key is depressed; then release the "O" key.

The relay should remain operated until the "H" key is released.

If relay fails to act properly, adjust it to meet requirements.

Release Current:

When a release current is specified, proceed as follows:

After adjusting the other slides to the specified requirements, depress the "R" key and by means of the #4 slides obtain the specified release current.

To test the relay -

- (a) Depress the "O" key.
- (b) If relay operates properly, depress the "R" key while the "O" key is depressed; then release the "O" key.

The relay should release promptly upon the release of the "O" key.

If relay fails to act properly, adjust it to meet requirements.

Slow Release Relays:

In testing slow release relays, proceed as follows:

1. Obtain the proper current value by depressing the "O" key and adjusting the #1 slides in the regular way.
2. Throw the "INT" key.
3. With the "O" key depressed, wind up the "1/2 Sec." or "slow" key and release the handle.

The relay should operate and release several times at 1/2 second intervals while the key is returning to normal.

4. With the "O" key depressed, wind up the "1/3 Sec." or "fast" key and release the handle.

The relay should operate but not release until the key has returned to its normal position.

If relay fails to act properly, adjust it to meet requirements.

Soaking Current:

When a "soaking" current is specified, use the "NO", "H", or "R" key and the corresponding resistance slides, as convenient, for obtaining the proper current value.

The relay should operate and release promptly when the "O" key is depressed and released after applying the "soak" current to the relay.

DASH-POT RELAYSpecial Features

The dash-pot or solenoid type of relay consists of three principle parts. The upper part is a solenoid magnet. The central part includes the contact arm and contact springs. The lower part is the plunger and oil pot, comprising the dash-pot from which the relay is named. (See Fig. #24)

The upper part is a magnet with a movable core or armature "A", part of which is normally in the magnet and part of which extends below the coil. When the magnet is energized, the armature or core is pulled up into the coil. Attached to the lower end of the core is a universal joint "UJ" with a small ring "R" mounted near the lower end. When the armature is pulled up the ring will push against the contact arm "CA", and thereby cause the contact stud "CS" to move the traveling spring "TS" against the front contacts "FC".

Attached to the lower end of the universal joint is a plunger rod "PR" which passes through a hole in the base and is attached to the plunger "P". This plunger is hollow and fits into a metal cup "C" which is screwed to the bottom of the base. The cup is partly filled with a special grade of oil which should be obtained from the Automatic Electric Co. No other oil shall be used for this purpose.

The plunger has several small holes in its top cover and two in the bottom. (The holes in the bottom of the plunger are not shown in the illustrations.) The large hole in the center is

closed normally, and also when the plunger is moving upward, by a small steel ball which is loose in the plunger. When the plunger moves downward the ball is displaced by the pressure of the oil and allows the oil to pass through the plunger more freely thus causing the plunger to quickly return to normal. The small hole is partly closed by the point of a screw called a needle valve "NV", which passes through the plunger to its top cover where it may be adjusted with a screw driver. The needle valve is held in place by a small locking plate "LP" which in turn is held by one of the plunger assembly screws "AS".

When the plunger is pulled upward by the armature, the oil above it is forced through the plunger. The only path for the oil is through the small hole which is partly closed by the needle valve. As the hole is small considerable time will elapse before all the oil above the plunger is passed to the bottom of the oil cup. This acts as a brake or drag on the upward movement of the armature and causes it to move upward very slowly.

The speed of movement is dependant upon the adjustment of the needle valve, the amount of oil in the oil pot and the quality of the oil. It is therefore necessary to use the proper grade of oil and to have the proper amount in the cup. The speed may then be adjusted by means of the needle valve.

A lead washer "W" is placed between the base of the relay and the top of the oil cup to prevent the leakage of oil.

The top of the base is depressed so that any oil collected by the plunger rod and carried out of the oil cup will drain back into the cup through the hole and not run down outside.

The plunger may be taken apart for inspection and cleaning by removing the two assembly screws "AS" and pulling the bottom part away from the cover. Care should be taken in replacing these screws as one is longer than the other in order to accommodate the thickness of the locking plate. The needle valve should be unscrewed a few times when the plunger is being re-assembled and then readjusted. The assembly screw holding the locking plate shall be first loosened before the needle valve is adjusted.

No cover is provided for this relay. The wiring for the magnet and contacts is connected to the top of the relay and is usually brought through a hole in the mounting board.

See page 88 for Mechanical Requirements.



Complete With Oil-cup removed

Fig. #24 Dash-Pot or Solenoid Relay (Front View)

MECHANICAL REQUIREMENTNormal Position of Armature

The armature should move in the solenoid or magnet without sticking. The depth of oil in the oil pot should be such that the plunger can be pulled up to within 1/8 inch of the top of the cylinder before the oil is out of the plunger. When this condition occurs the plunger will move quicker than before the oil is completely out.

The contact springs should have a minimum separation of .005 inches. The front contact springs should have a follow of at least .005 inches. The contact arm "CA" should be firmly pressed against the back stop spring "BSS" and should clear the universal joint.

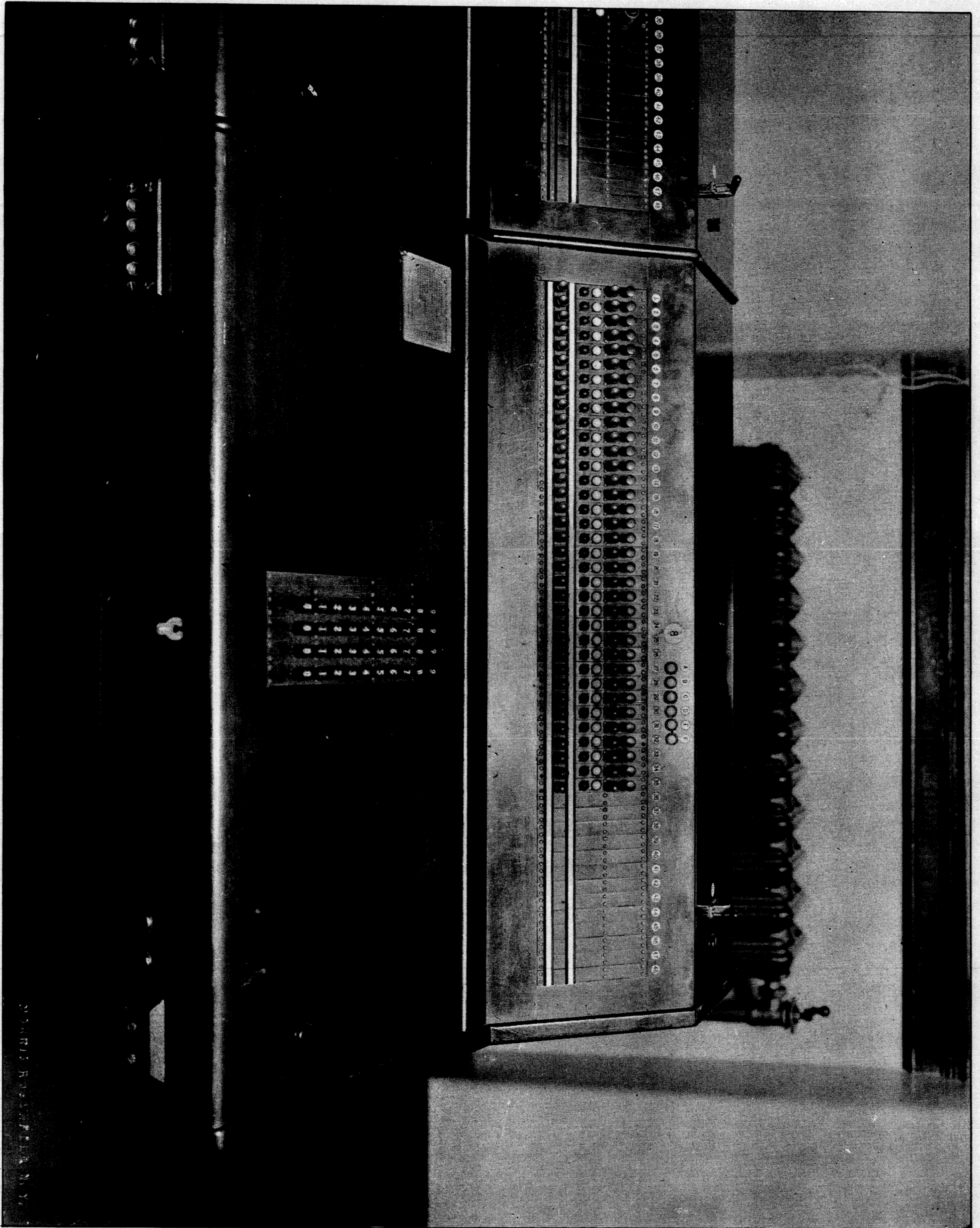
Operated Position of Armature

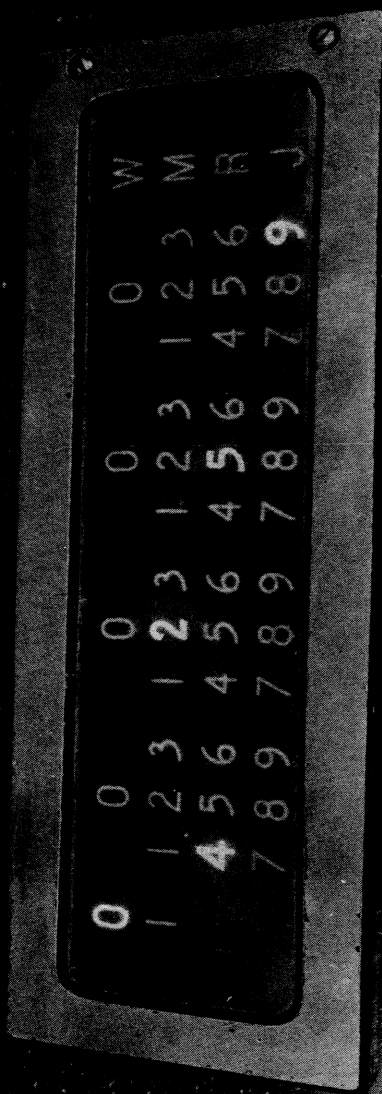
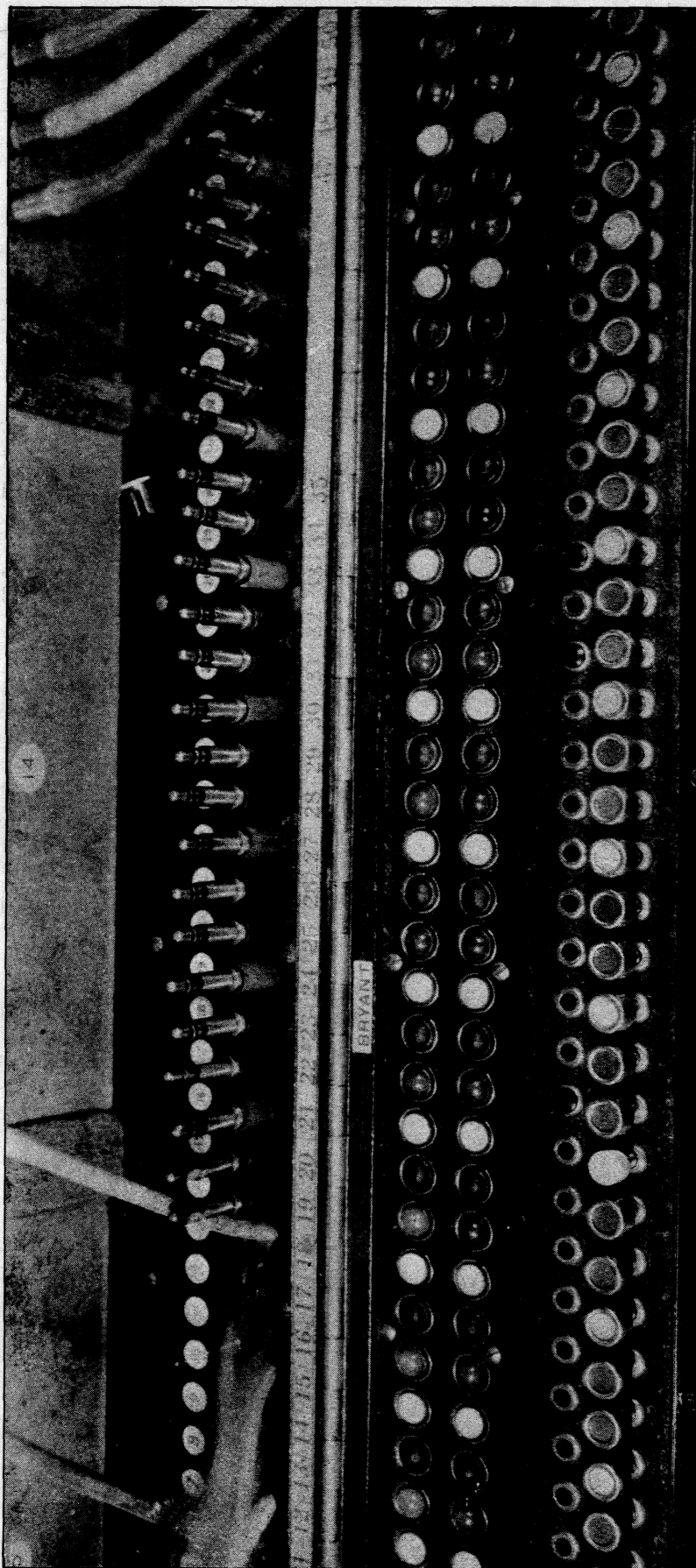
The upward movement is limited by the top of the needle valve screw touching the bottom of the base and is not adjustable. The needle valve should be so adjusted that about thirty seconds will elapse from the time the magnet is energized until the contacts are closed. A pocket watch may be used to time the adjustment. Several O.K. tests shall be made after a re-adjustment before the adjustment shall be considered satisfactory.

Turning the needle valve clockwise causes the relay to operate slower and counter-clockwise causes the relay to operate faster. The plunger should return to normal quickly and smoothly when the magnet releases.





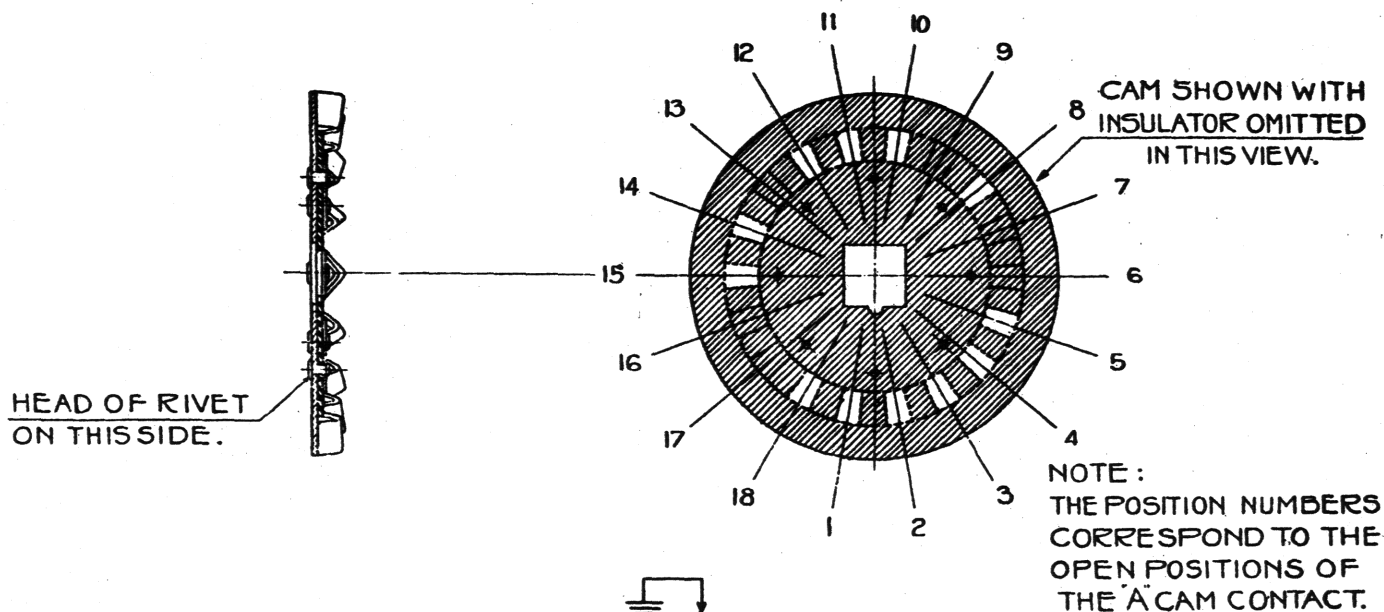




0	1	2	3	4	5	6	7	8	9	W	M	R	J
0	1	2	3	4	5	6	7	8	9				
0	1	2	3	4	5	6	7	8	9				
0	1	2	3	4	5	6	7	8	9				

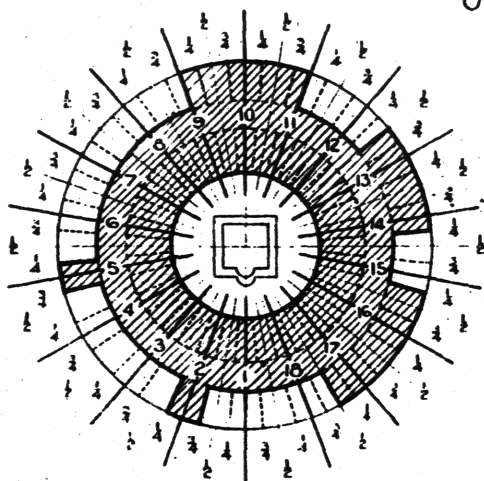
SEQUENCE SWITCH CAM CUTTINGS AND CIRCUIT CONVENTIONS

"A" CAM

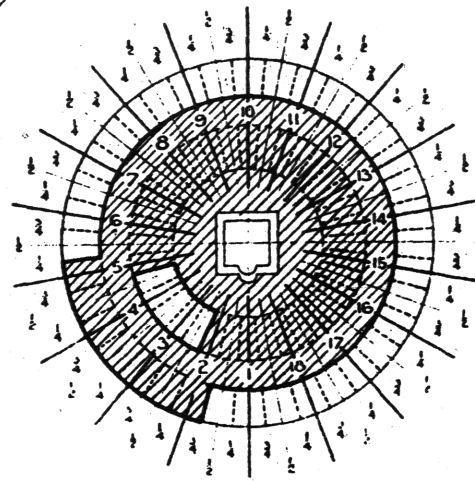


18- POSITION CAM

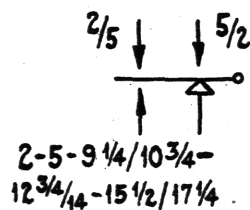
HEAD OF RIVET ON RIGHT SIDE



LEFT



RIGHT



[illegible][illegible]

MACHINE SWITCHING SYSTEM

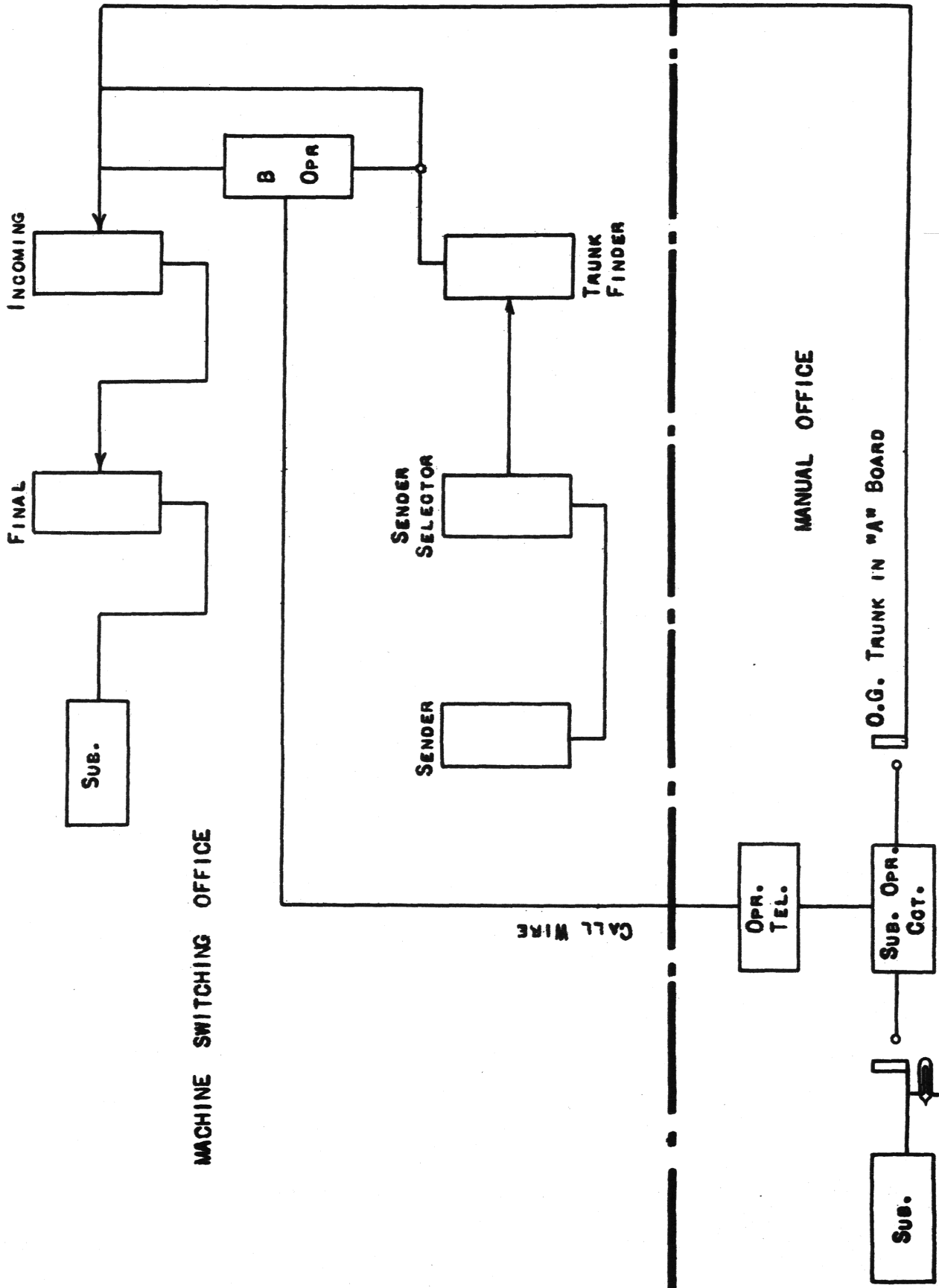
CONNECTION FROM MANUAL OFFICE SUBSCRIBER TO
MACHINE SWITCHING OFFICE SUBSCRIBER

706-64
PROVISIONAL

ENGINEER
DRAFTSMAN
CHECKED BY *WAP*

L #16275 MAR. 28.17

ISSUE 1.



MACHINE SWITCHING SYSTEM

PANEL TYPE
ARRANGEMENTS OF LINE FINDER MULTIPLE BANKS

806 - 8
INFORMATION

Emmett C. C. S.
Drawing Room
Checked by

Issue #1
SEPT. 1, 1920

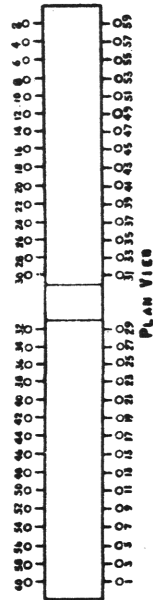
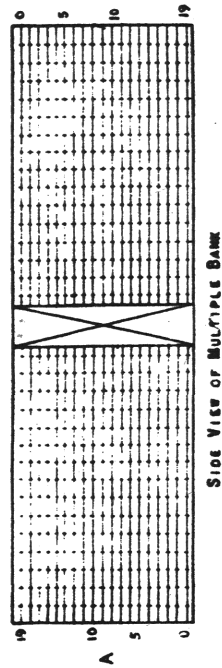


FIG. 1 ARRANGEMENT OF MULTIPLE BANK USED FOR TERMINATING
300 LINES PER FRAME. 300 LINES MULTPLIED BEFORE A
MAXIMUM OF 60 LINE FINDERS

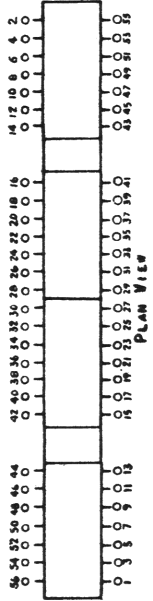
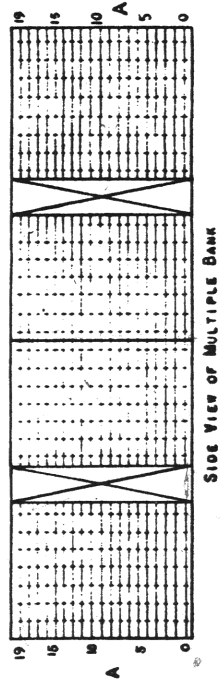


FIG. 3 ARRANGEMENT OF MULTIPLE BANK USED FOR TERMINATING
600 LINES PER FRAME. 300 LINES MULTPLIED BEFORE A
MAXIMUM OF 28 LINE FINDERS.

NOTE: "A" INDICATES THE END OF THE
MULTIPLE BANKS ADJACENT TO THE
LINE RELAY RACK.

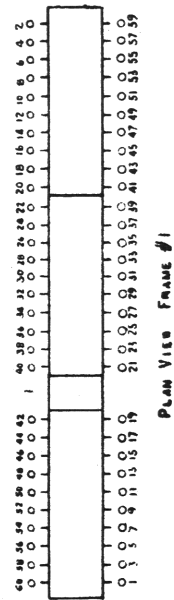
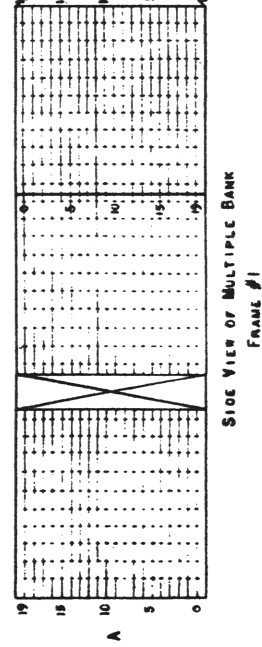
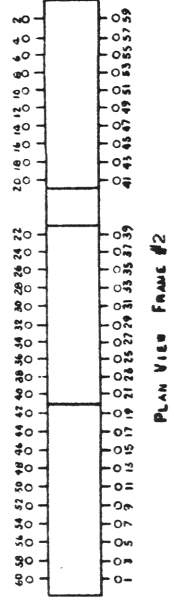
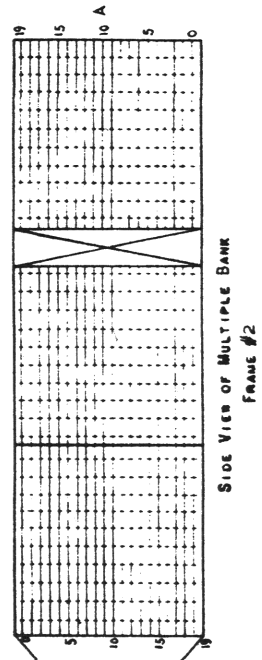


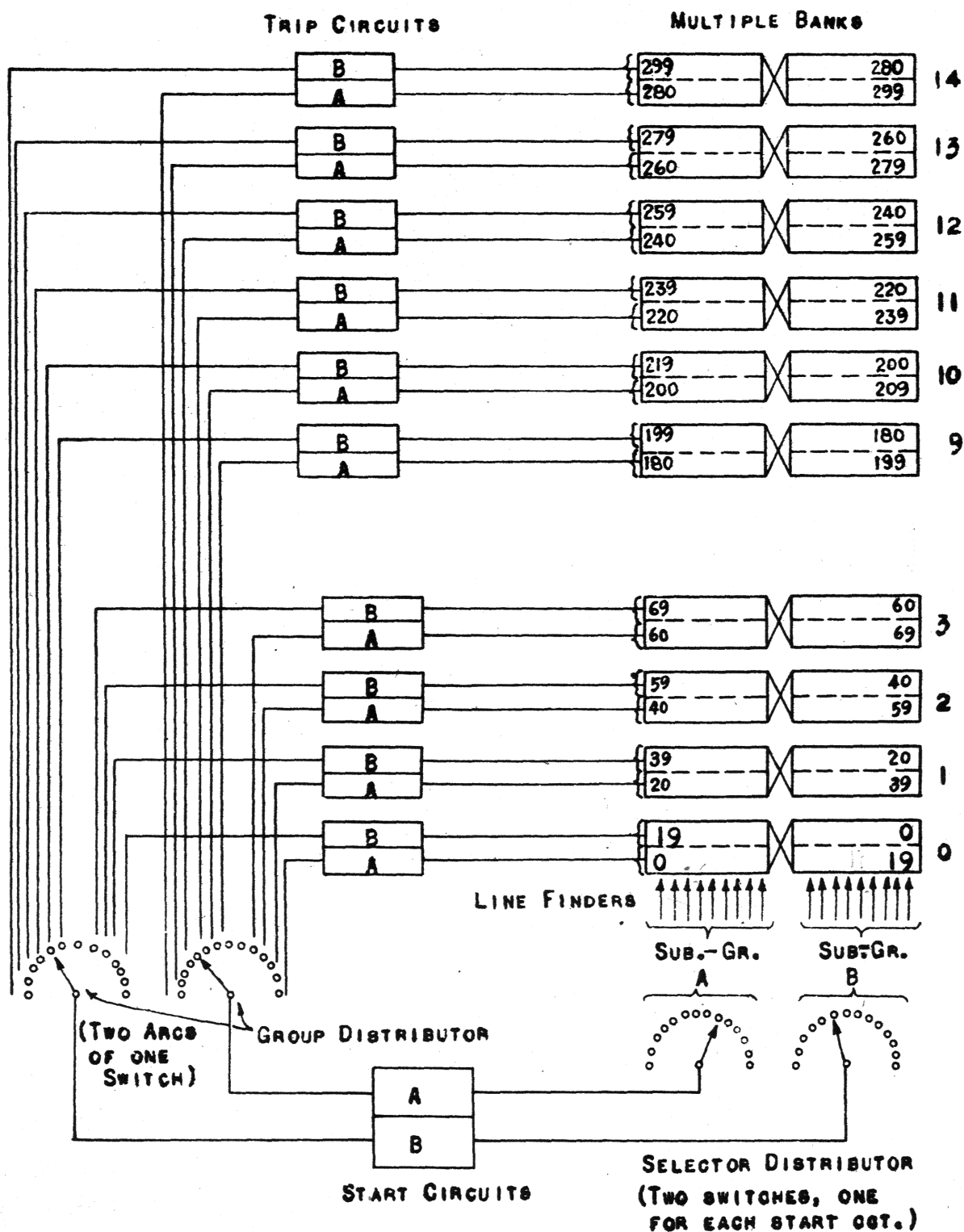
FIG. 2 ARRANGEMENT OF MULTIPLE BANKS USED FOR TERMINATING
900 LINES ON TWO ADJACENT FRAMES. 300 LINES MULTPLIED
BEFORE A MAXIMUM OF 40 LINE FINDERS



MACHINE SWITCHING SYSTEM

PANEL TYPE
ARRANGEMENT OF LINE FINDER CIRCUITS

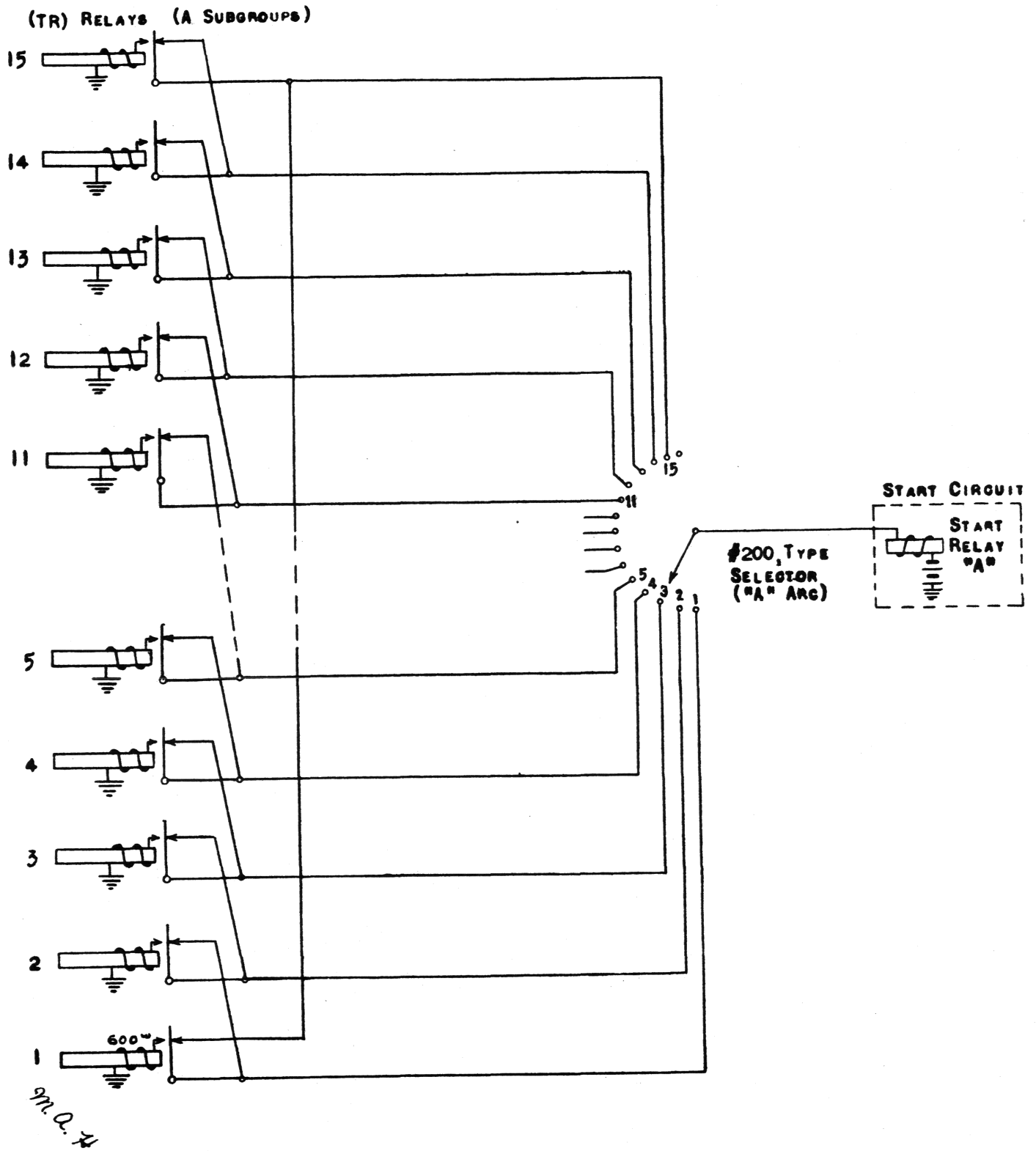
806 - 10
INFORMATION
SEPT. 1, 1920
ENGINEER *elb*
DRAFTSMAN

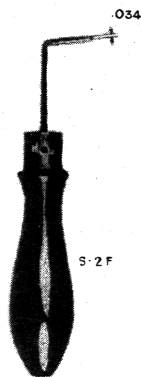


A. T. & T. Co.
ENG. DEPT.

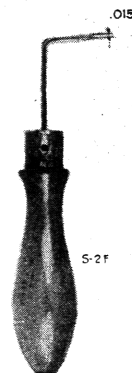
MACHINE SWITCHING SYSTEM
PANEL TYPE
WIRING OF GROUP DISTRIBUTOR

806 - 11
INFORMATION
SEPT. 1, 1920
ENGINEER *Ees*
DRAFTSMAN

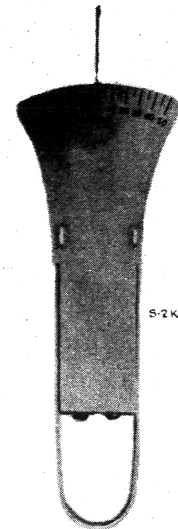




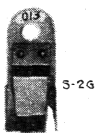
Nº 41



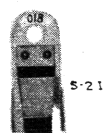
Nº 42



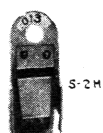
Nº 70 TENSION GAUGE



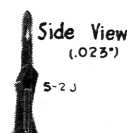
Nº 65 A



Nº 65 B

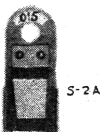


Nº 65 C

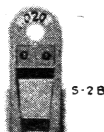


Nº 65 D

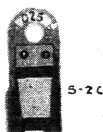
Nº 64 A ASSEMBLED ON A RING



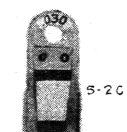
Nº 67 A



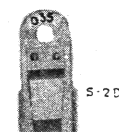
Nº 67 B



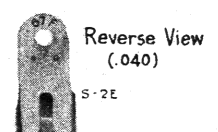
Nº 67 C



Nº 67 D

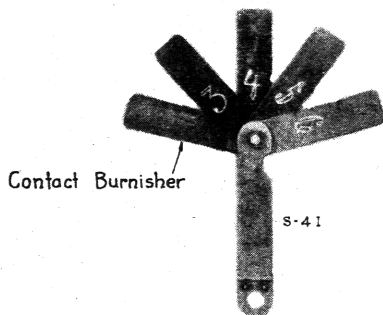


Nº 67 E

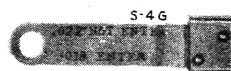


Nº 67 F

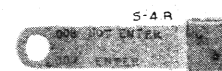
Nº 66 A ASSEMBLED ON A RING



Nº 74 A

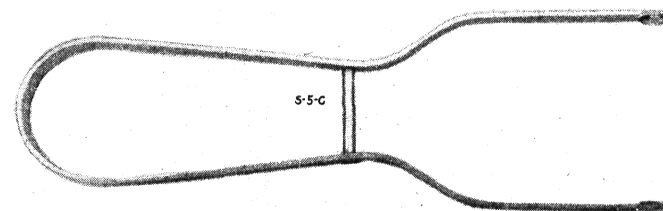


Nº 73 A



Nº 73 B

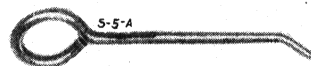
Fig. 4-A Gauges for Adjusting Relays (Half Actual Size)



Nº 90 MESS. REG. CAP EXTRACTOR



Nº 265- CONTACT BURNISHER



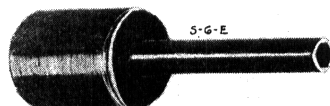
Nº 212-STUD ADJUSTER



Nº 208 - WRENCH



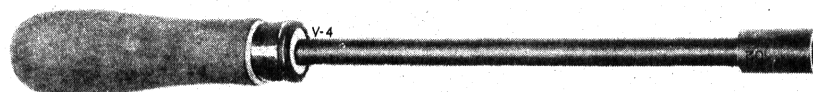
Nº 219 - SOCKET WRENCH



Nº 220 - SOCKET WRENCH



Nº 231 - WRENCH



Nº 102-SOCKET WRENCH



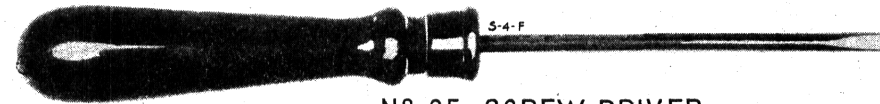
Nº 136-WEDGE



Nº 252-CONTACT CLIP



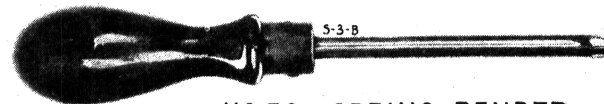
Nº 206 - 30° SCREW DRIVER



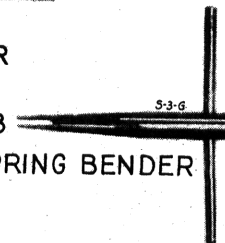
Nº 35-SCREW DRIVER



Nº 207 - 90° SCREW DRIVER



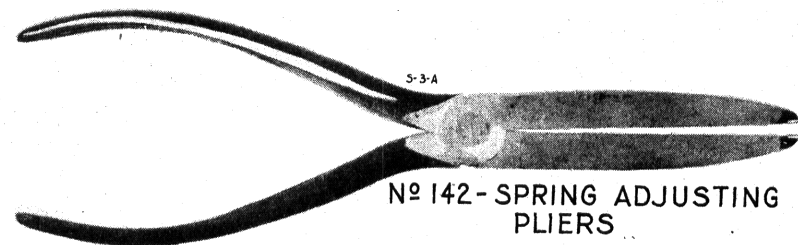
Nº 50 - SPRING BENDER



Nº 98
SPRING BENDER



Nº 259 SPRING BENDER



Nº 142- SPRING ADJUSTING
PLIERS



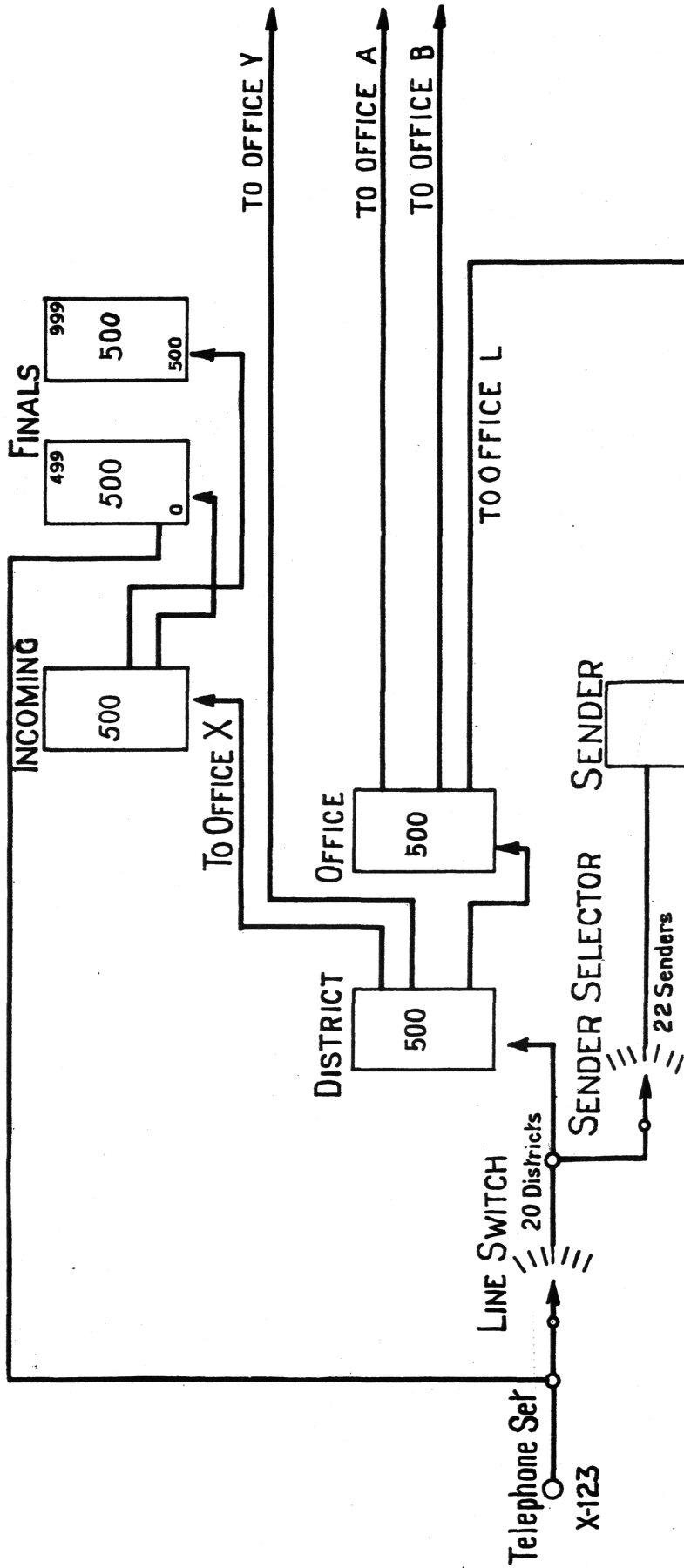
Nº 264-LUG BENDER

Half Actual Size

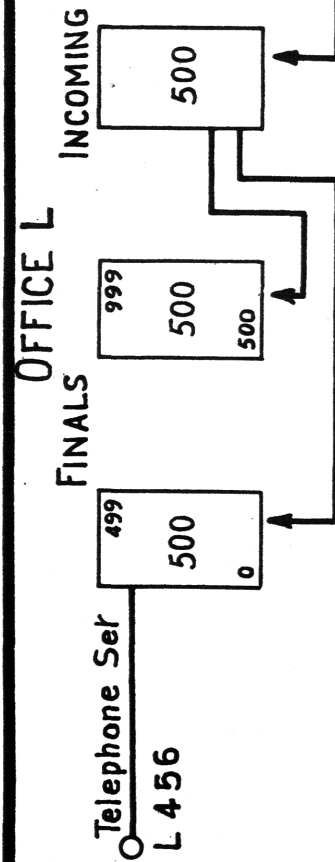
FIG.4 TOOLS FOR ADJUSTING RELAYS - MACHINE SWITCHING EQUIPMENT

FULL MECHANICAL - 500 POINT SELECTORS SCHEMATIC SHOWING ORDER OF SELECTION

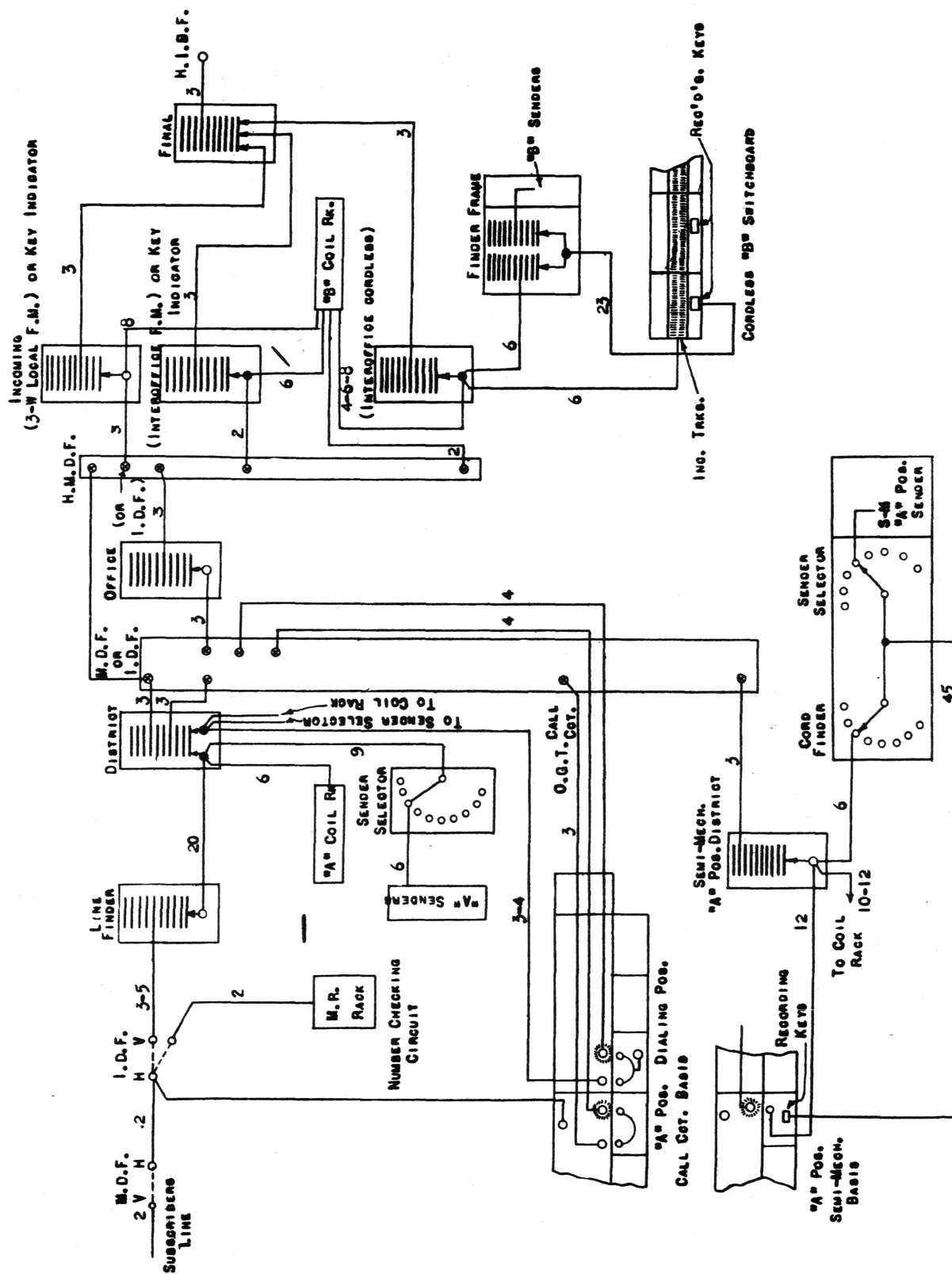
38-Y-1048
Dec. 12, 1918.



OFFICE X

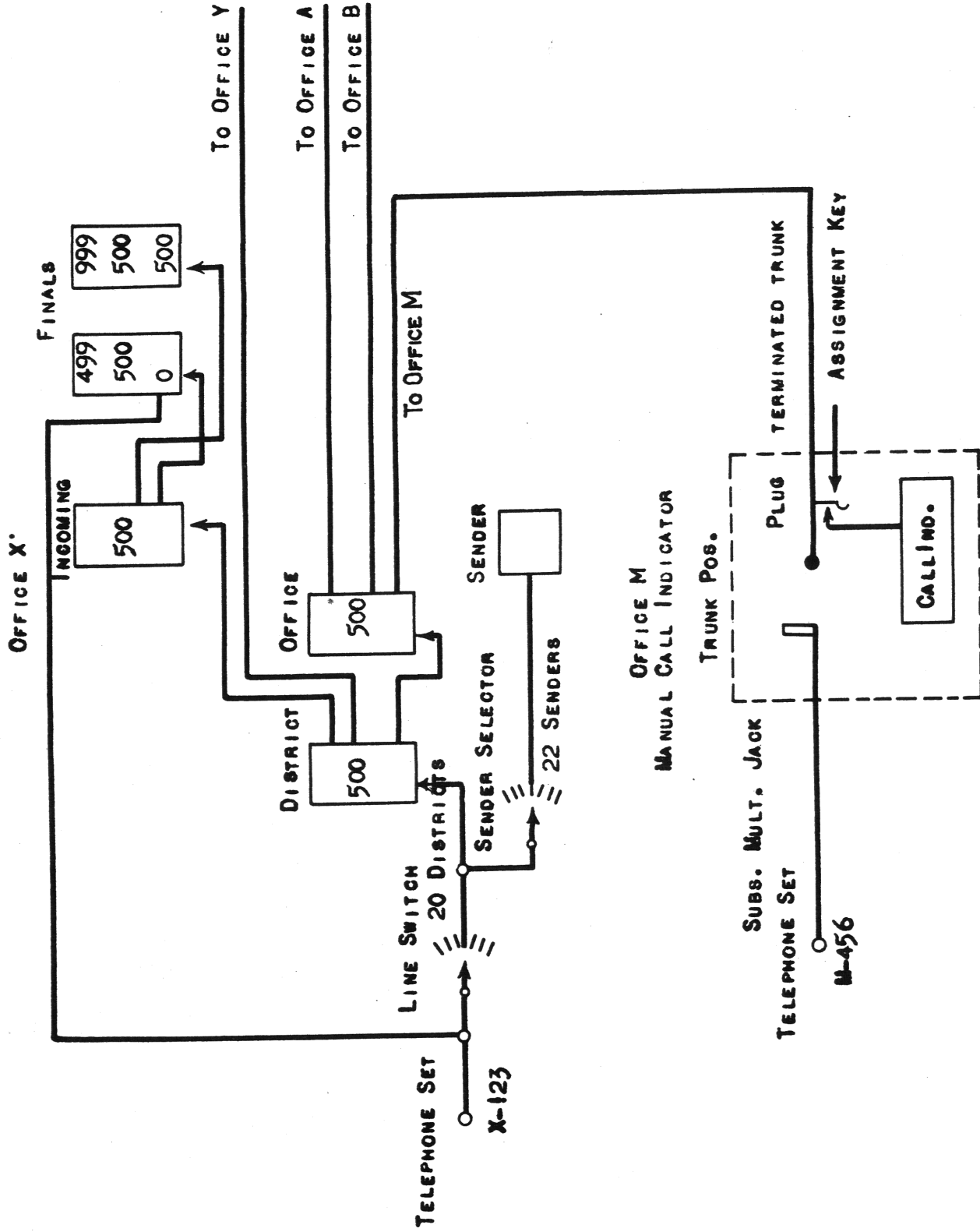


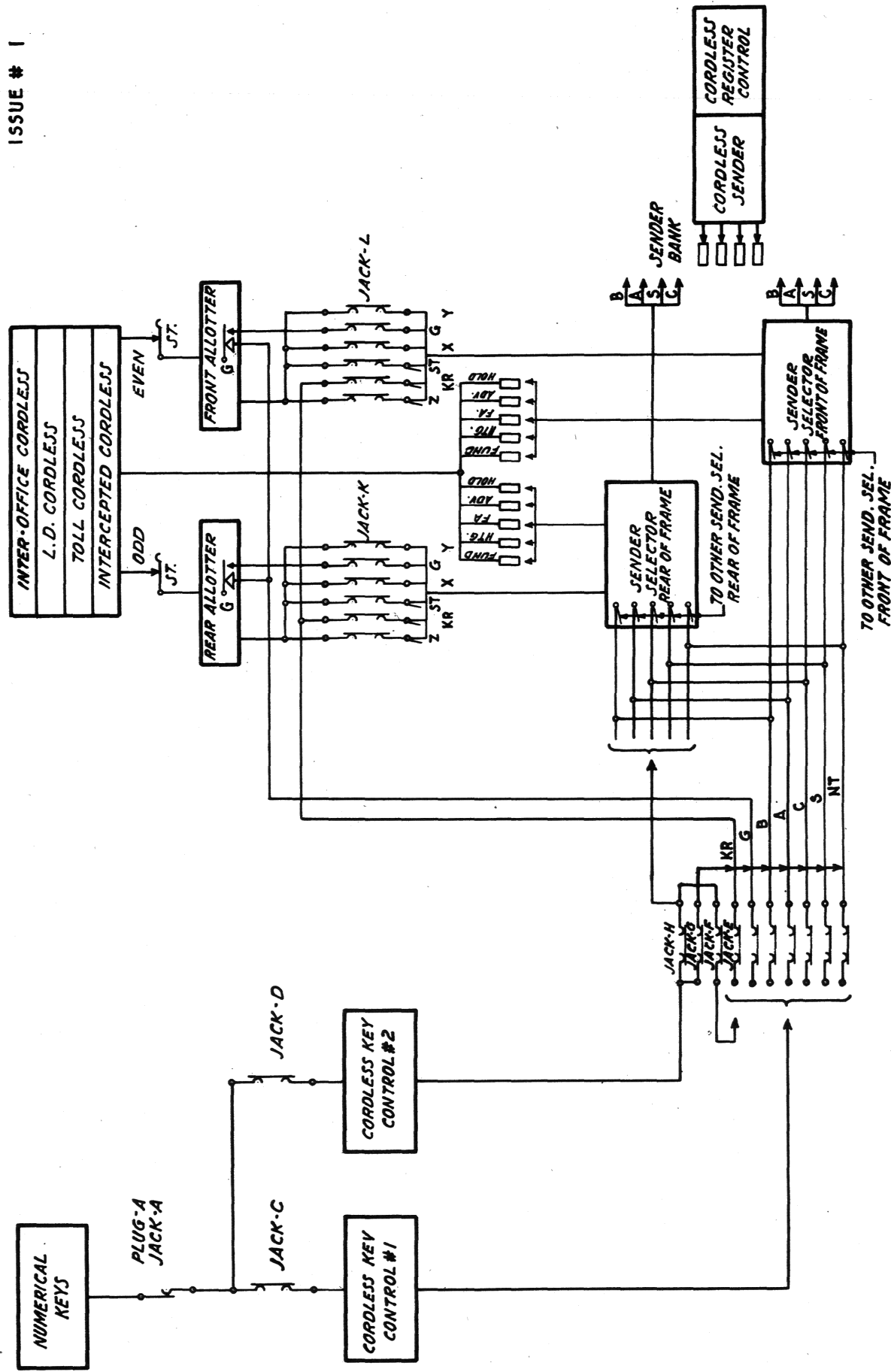
FULL MECHANICAL OFFICE
SCHEMATIC DIAGRAM



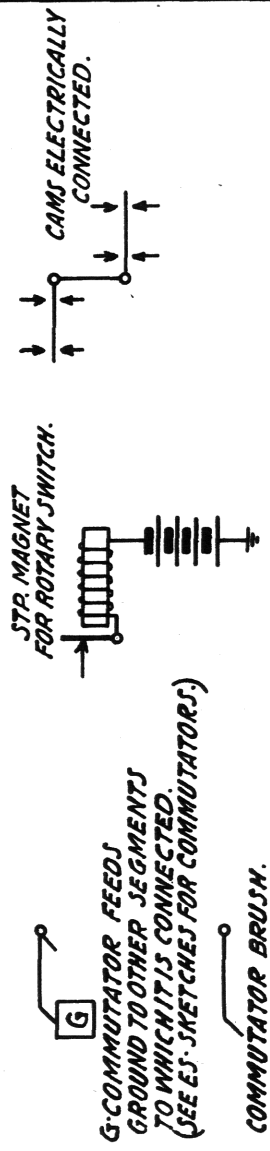
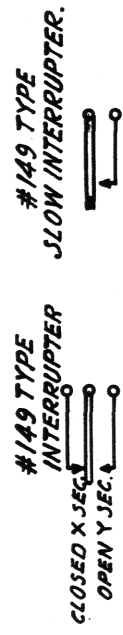
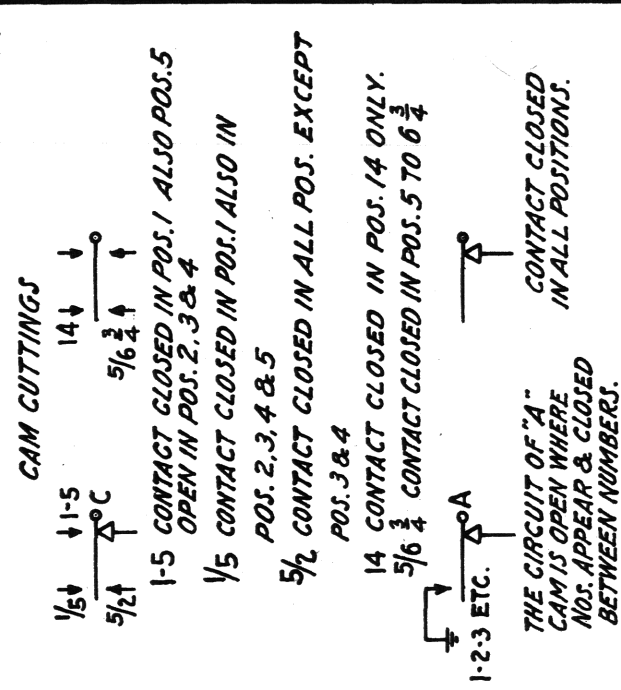
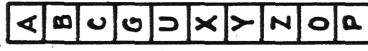
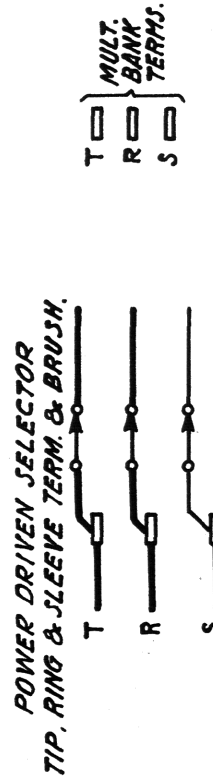
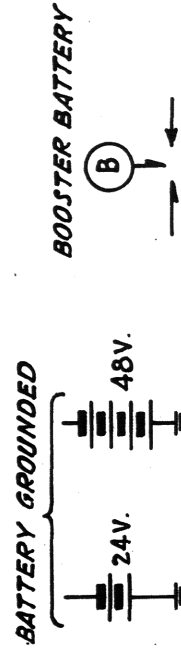
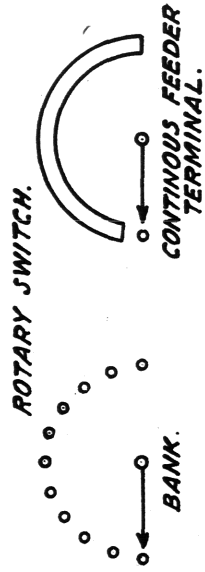
MACHINE SWITCHING SYSTEM

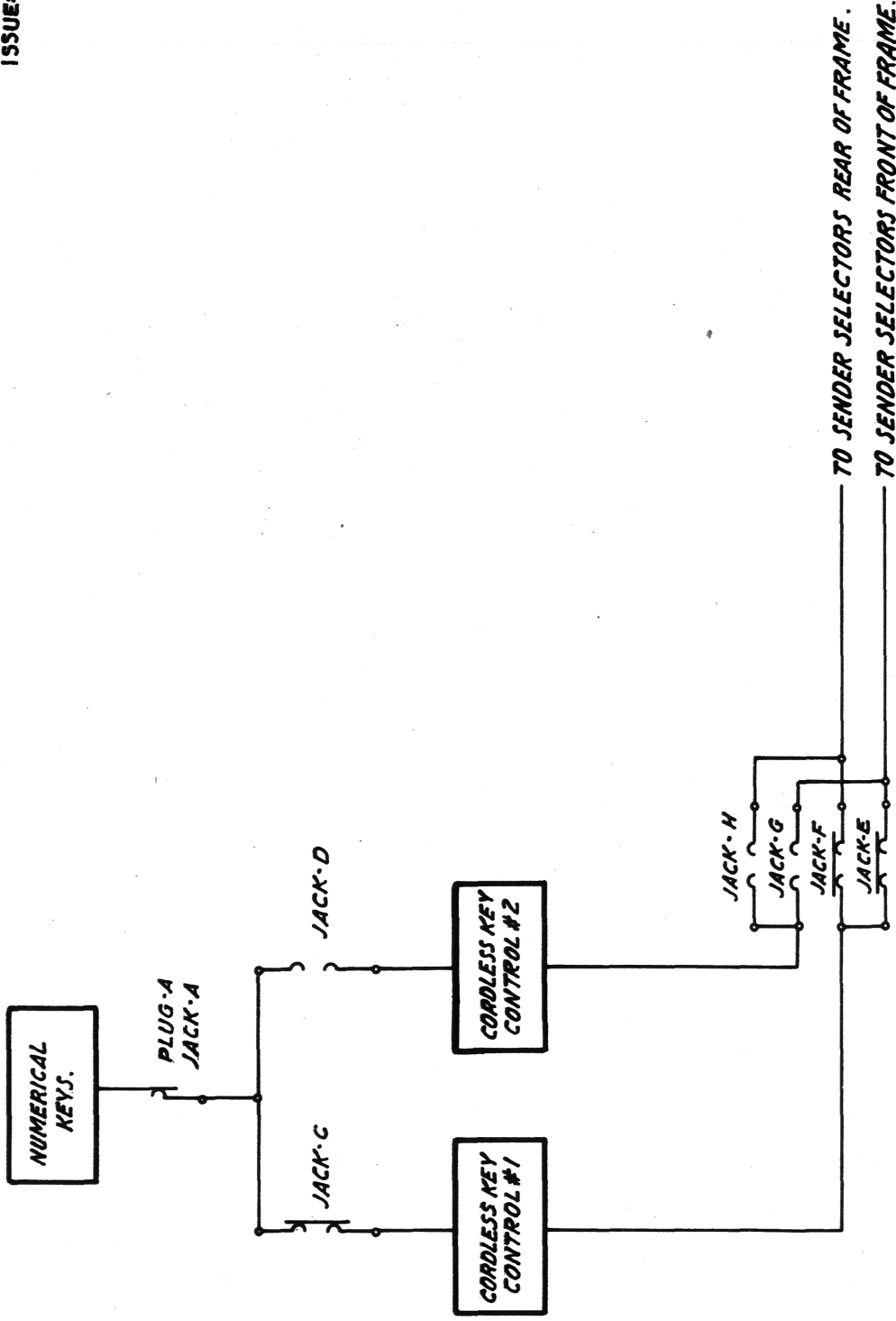
CONNECTION FROM MACHINE SWITCHING OFFICE SUBSCRIBER
TO MANUAL OFFICE SUBSCRIBER





CORDLESS "B" BOARD.
SHOWING ARRANGEMENT OF JACKS & PLUGS CONNECTING
SENDER SELECTORS ON FRONT & REAR OF FRAMES & TO THE
FRONT & REAR ALLOTTERS.

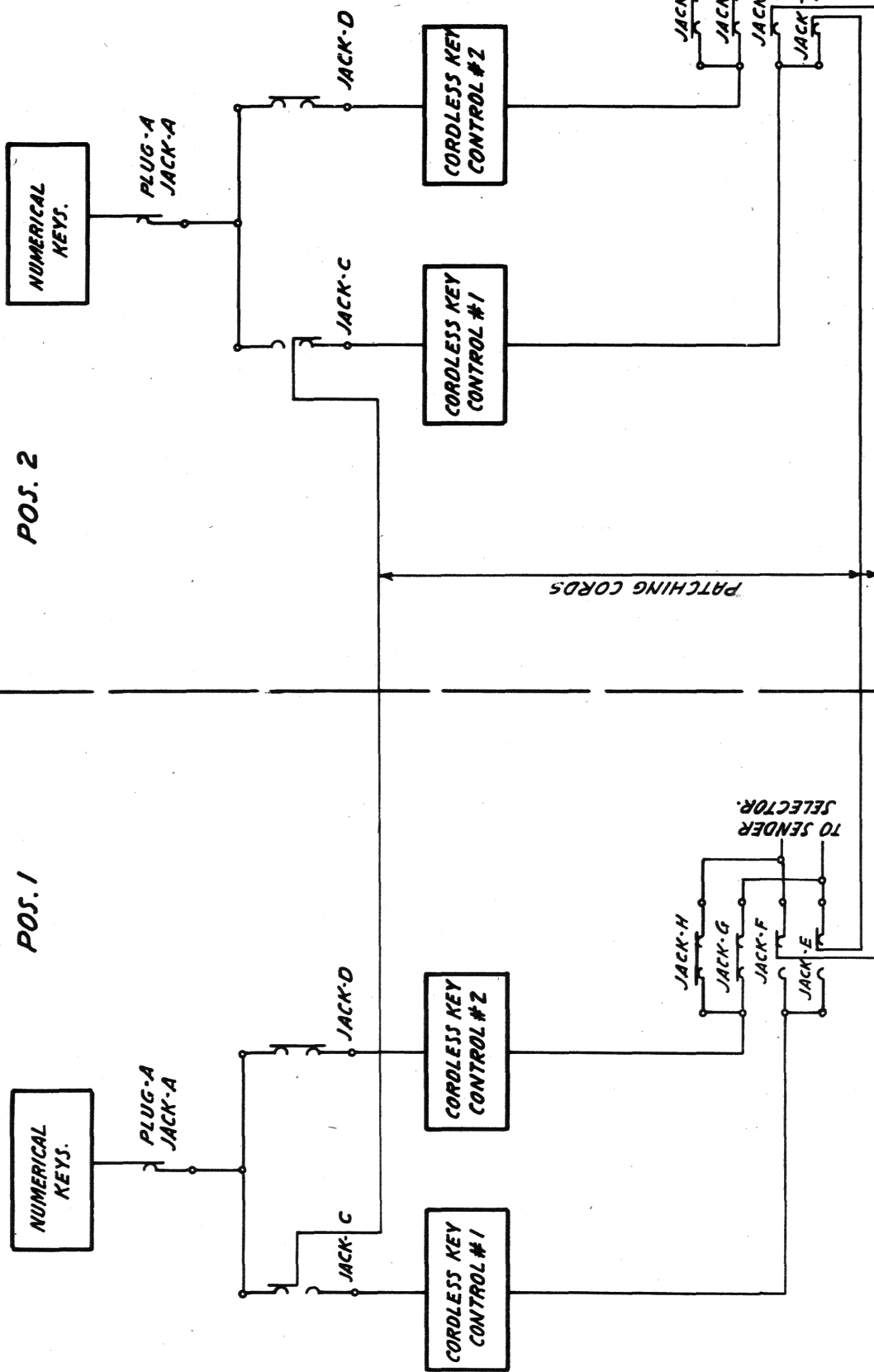




CORDLESS "B" BOARD.
SHOWING ONE KEY CONTROL CIRCUIT WORKING.

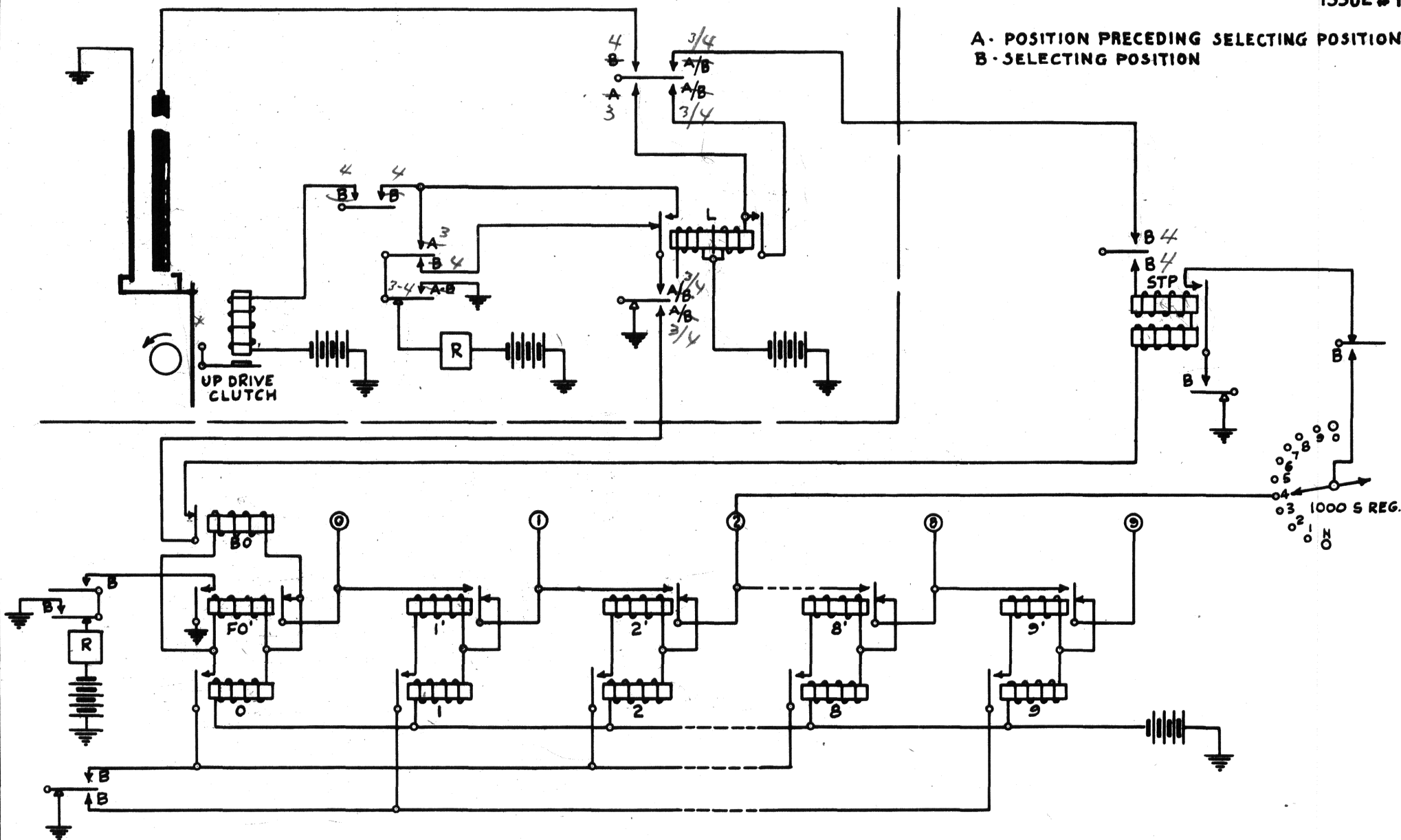
POS. 2

POS. 1



*CORDLESS "B" BOARD.
SHOWING PATCHING CORD CONNECTIONS WHEN ONE KEY
CONTROL CIRCUIT IS BORROWED FROM ANOTHER POSITION.*

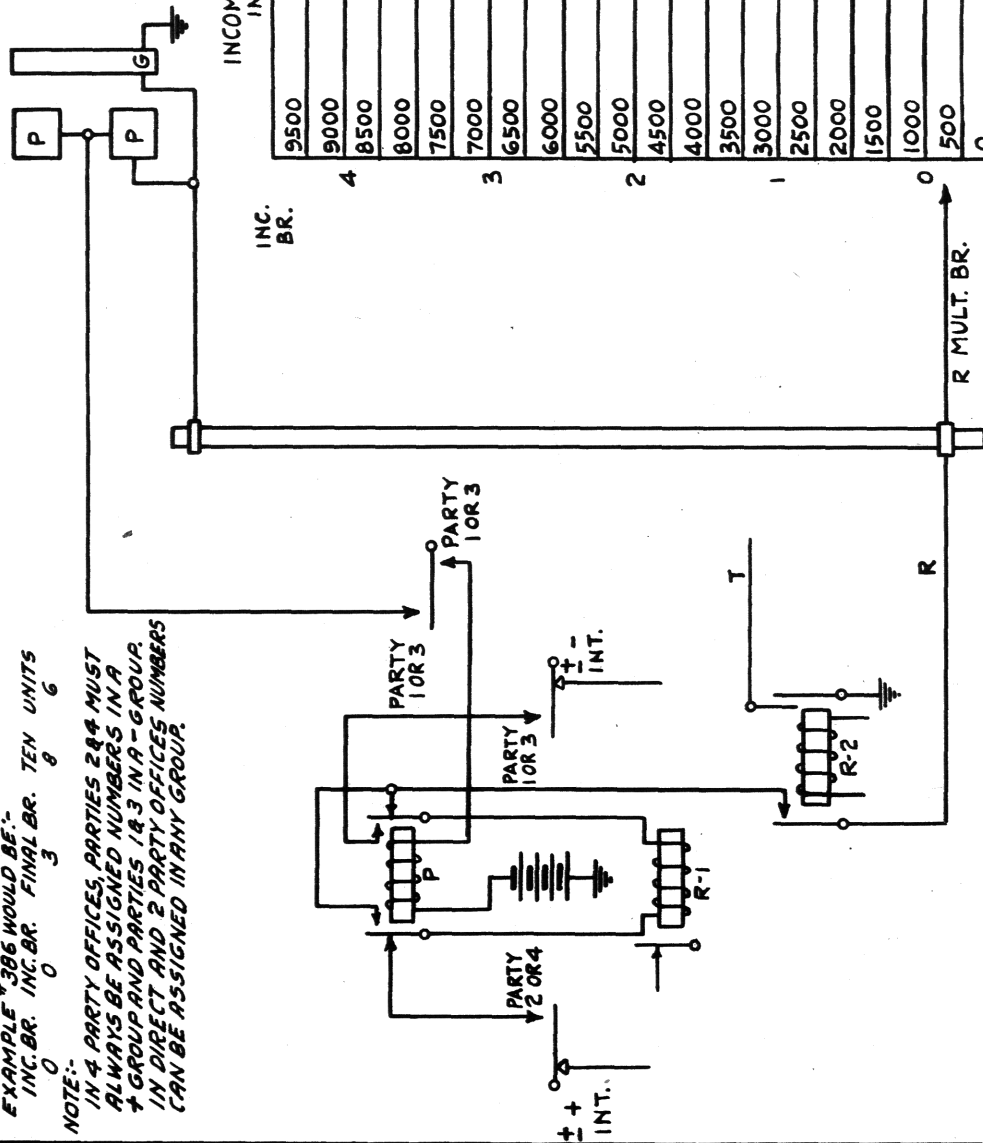
A - POSITION PRECEDING SELECTING POSITION.
B - SELECTING POSITION



FUNDAMENTAL & COUNTING RELAY CIRCUIT.
PANEL TYPE POWER DRIVEN SYSTEM.

EXAMPLE #386 WOULD BE:-
INC. BR. INC. BR. FINAL BR. TEN UNITS
0 0 3 8 6

NOTE:-
IN 4 PARTY OFFICES, PARTIES 2 & 4 MUST
ALWAYS BE ASSIGNED NUMBERS IN A
+ GROUP AND PARTIES 1 & 3 IN A - GROUP.
IN DIRECT AND 2 PARTY OFFICES NUMBERS
CAN BE ASSIGNED IN ANY GROUP.

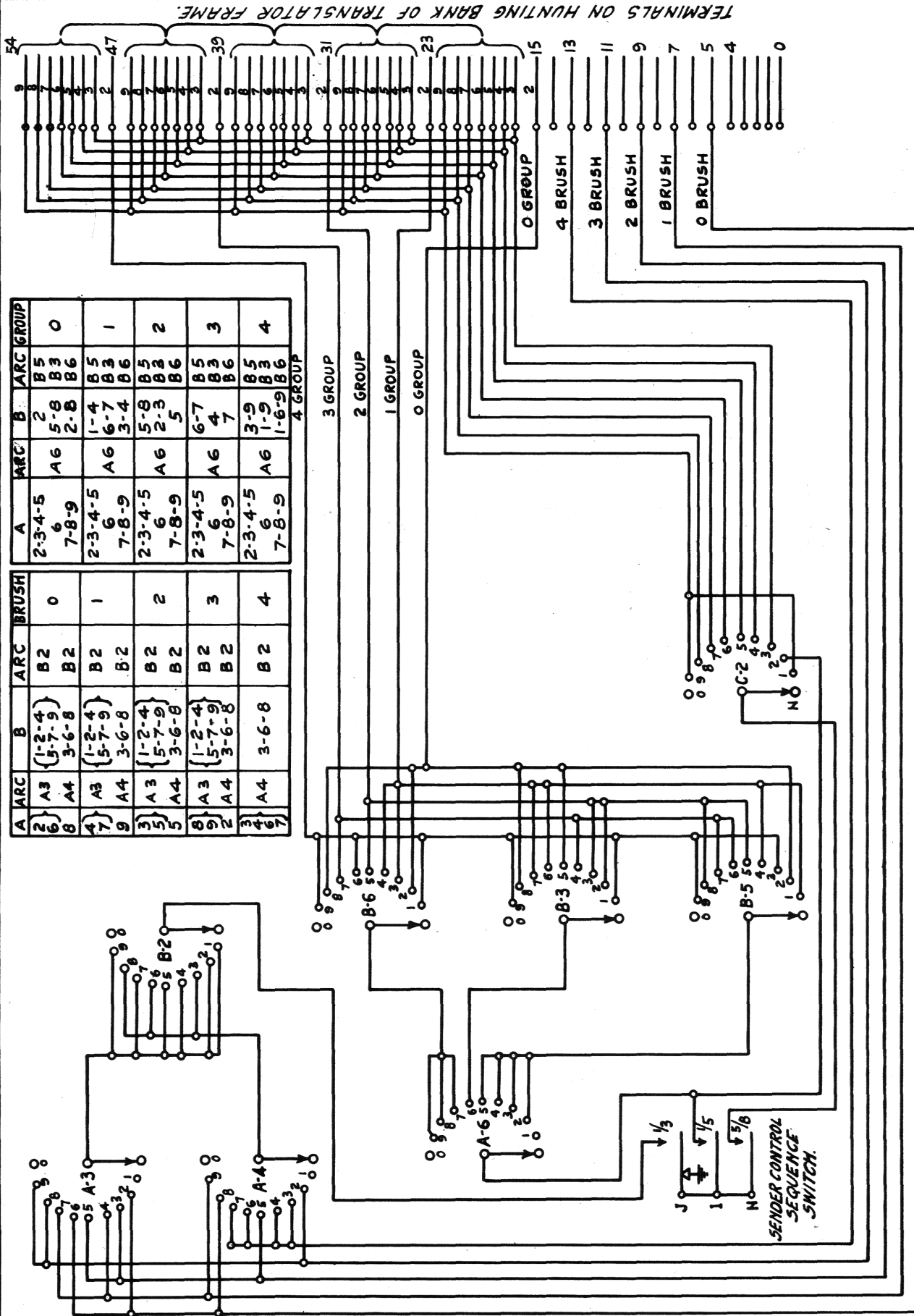


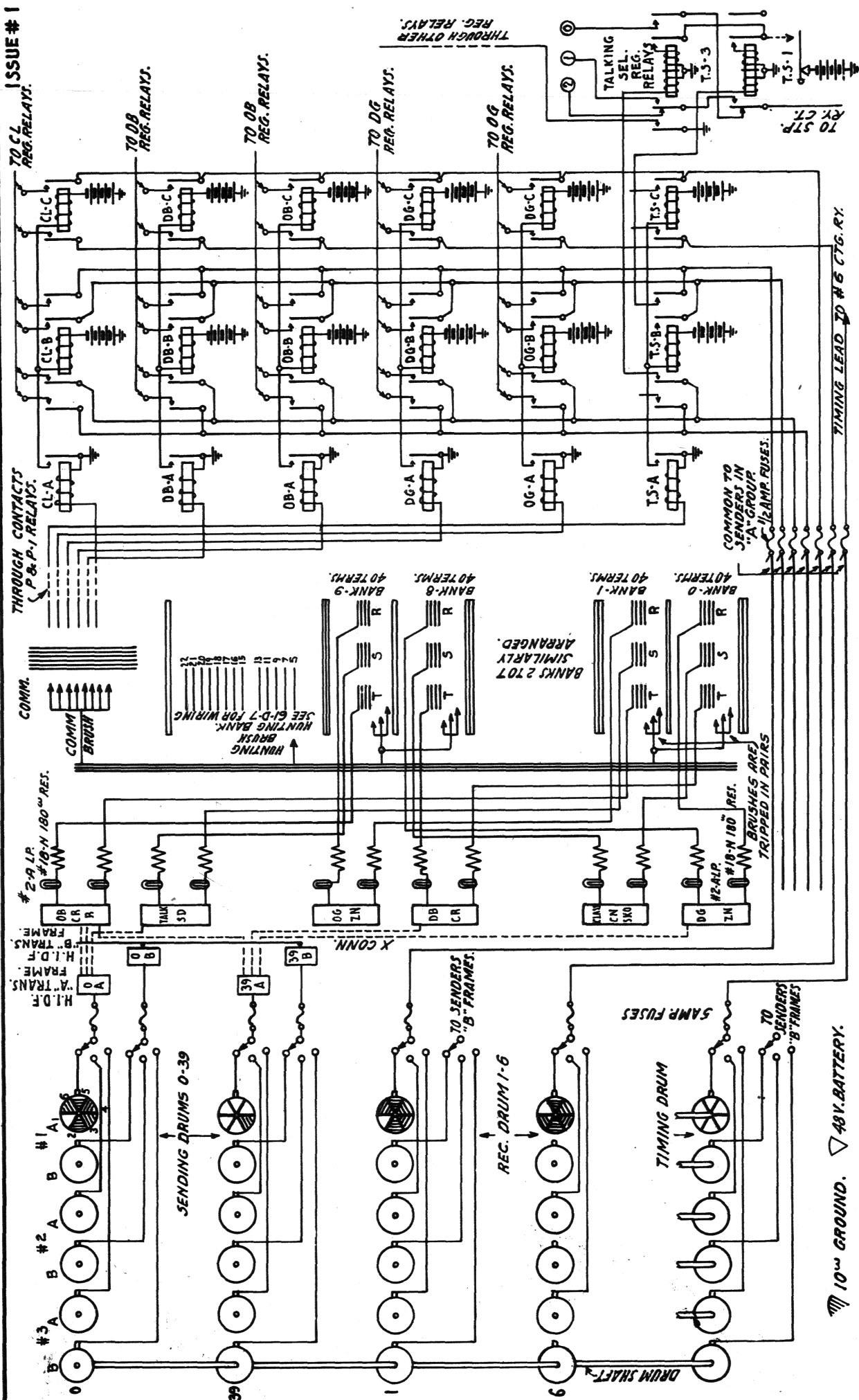
INCOMING FRAME
INC. GR.

INC. BR.	INC. GR.	FINAL BR.	FINAL FRAME
9500	3 -	9999	499
9000	2 +	9499	
8500	1 -	8999	
8000	0 +	8499	400
7500	3 -	7999	399
7000	2 +	7499	
6500	1 -	6999	
6000	0 +	6499	300
5500	3 -	5999	299
5000	2 +	5499	
4500	1 -	4999	200
4000	0 +	4499	199
3500	3 -	3999	
3000	2 +	3499	
2500	1 -	2999	100
2000	0 +	2499	99
1500	3 -	1999	
1000	2 +	1499	
500	1 -	999	
0	0 +	499	0

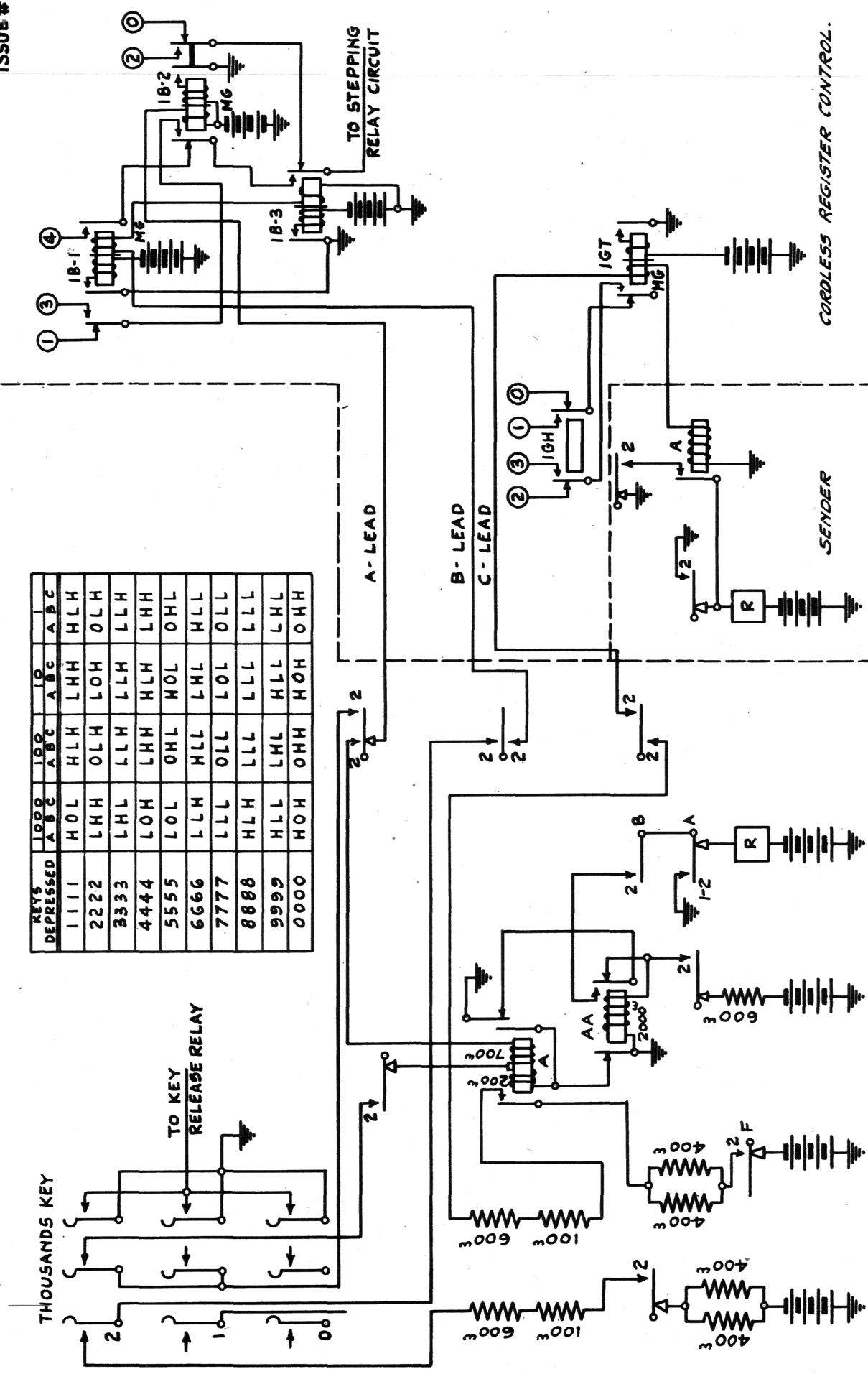
TO OTHER FINAL FRAMES

NUMERICAL TRANSLATION & RINGING SELECTION. MACHINE SWITCHING OFFICES.

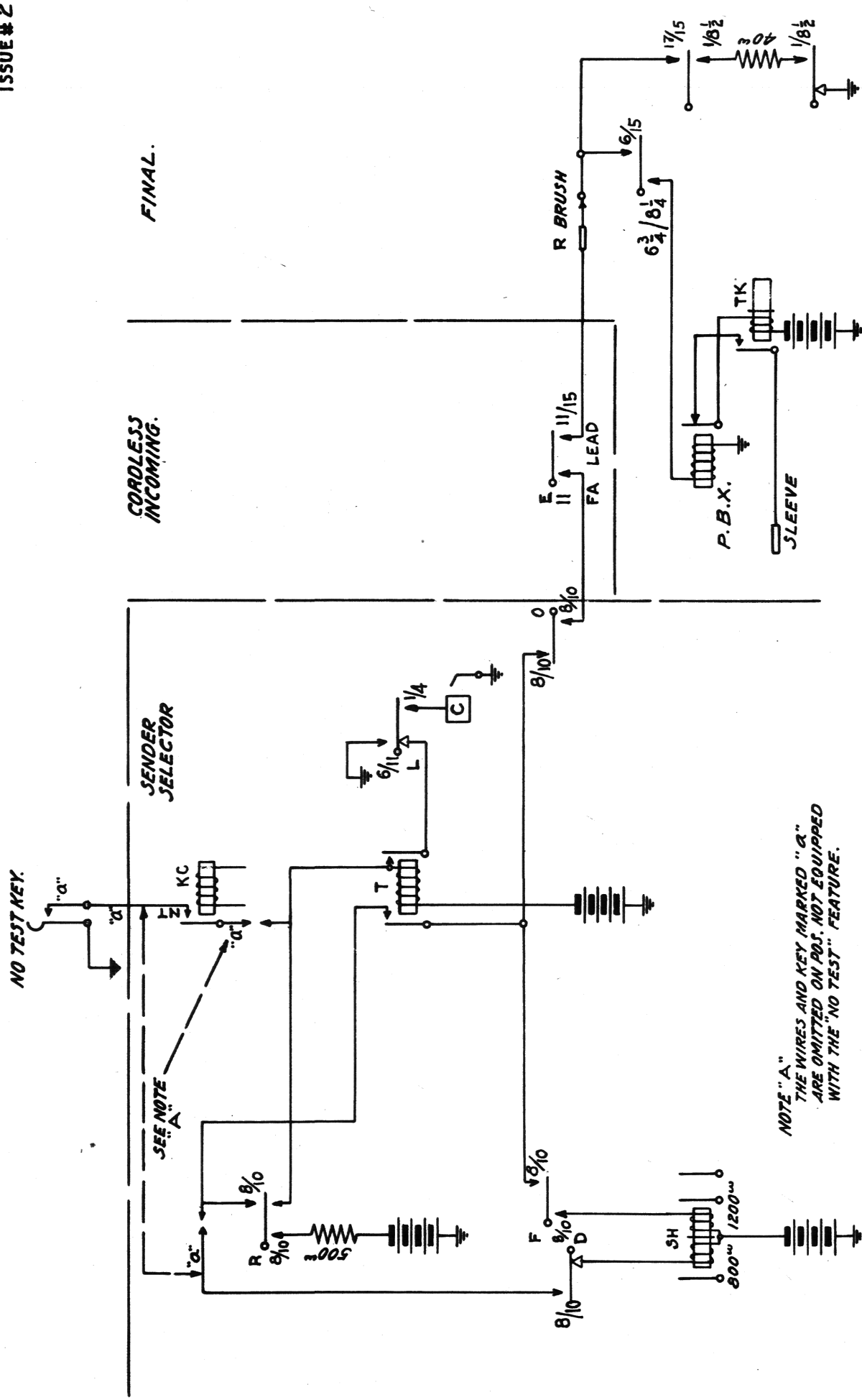




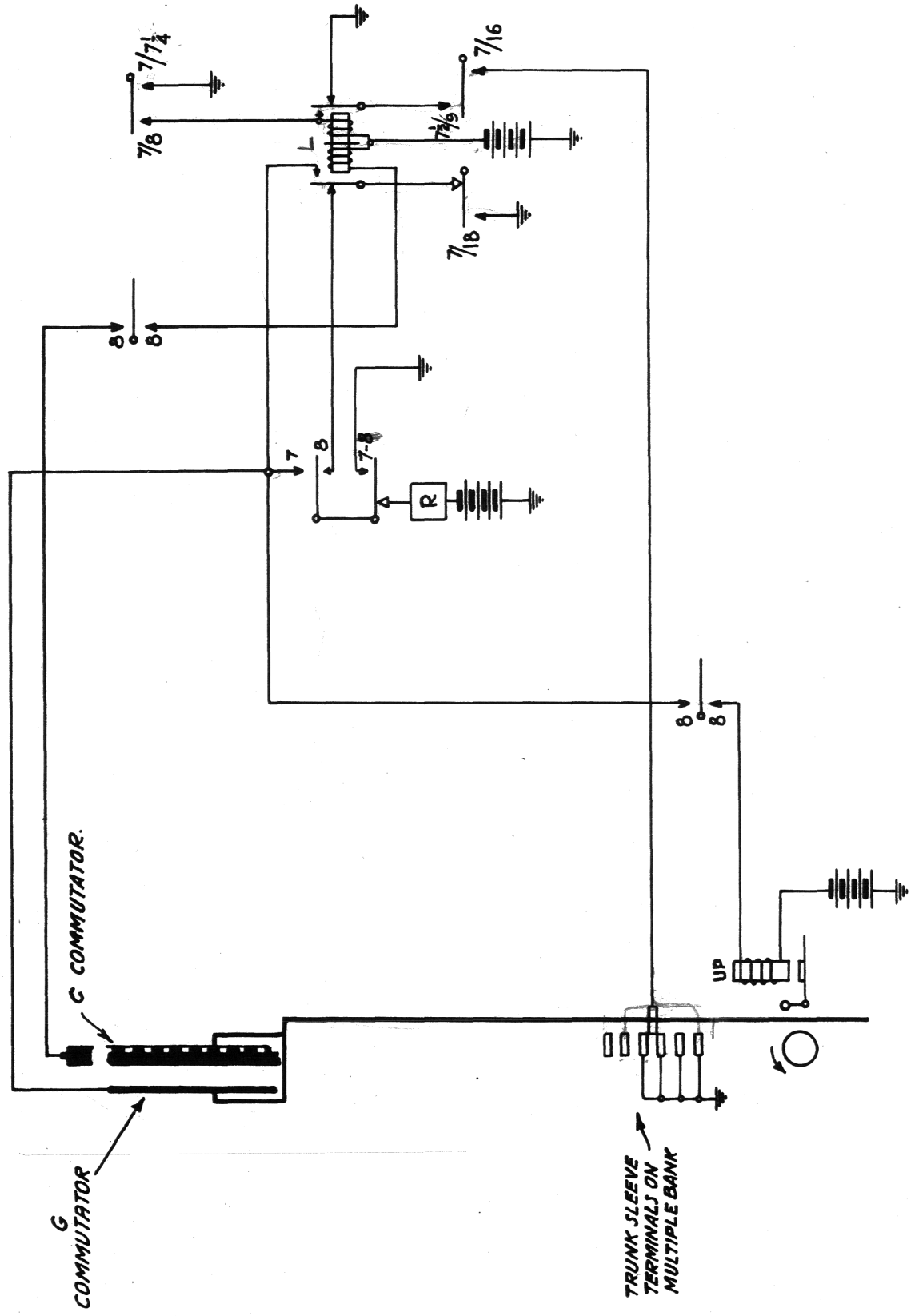
KEYS DEPRESSED	1000 A B C	100 A B C	10 A B C	1 A B C
1111	HOL	HLH	LHH	HLH
2222	LHH	OLH	LOH	OLH
3333	LHL	LLH	LLH	LLH
4444	LOH	LHH	HLH	LHH
5555	LOL	OHL	HOL	OHL
6666	LHL	HLL	LHL	HLL
7777	LLL	OLL	LOL	OLL
8888	HLH	LLL	LLL	LLL
9999	HLL	LHL	HLL	LHL
0000	HOH	OHH	HOH	OHH



CORDLESS "B" BOARD
SHOWING METHOD OF SETTING REGISTER CIRCUIT BY NUMERICAL KEYS.



**CORDLESS "B" BOARD.
"NO TEST" FEATURE.**



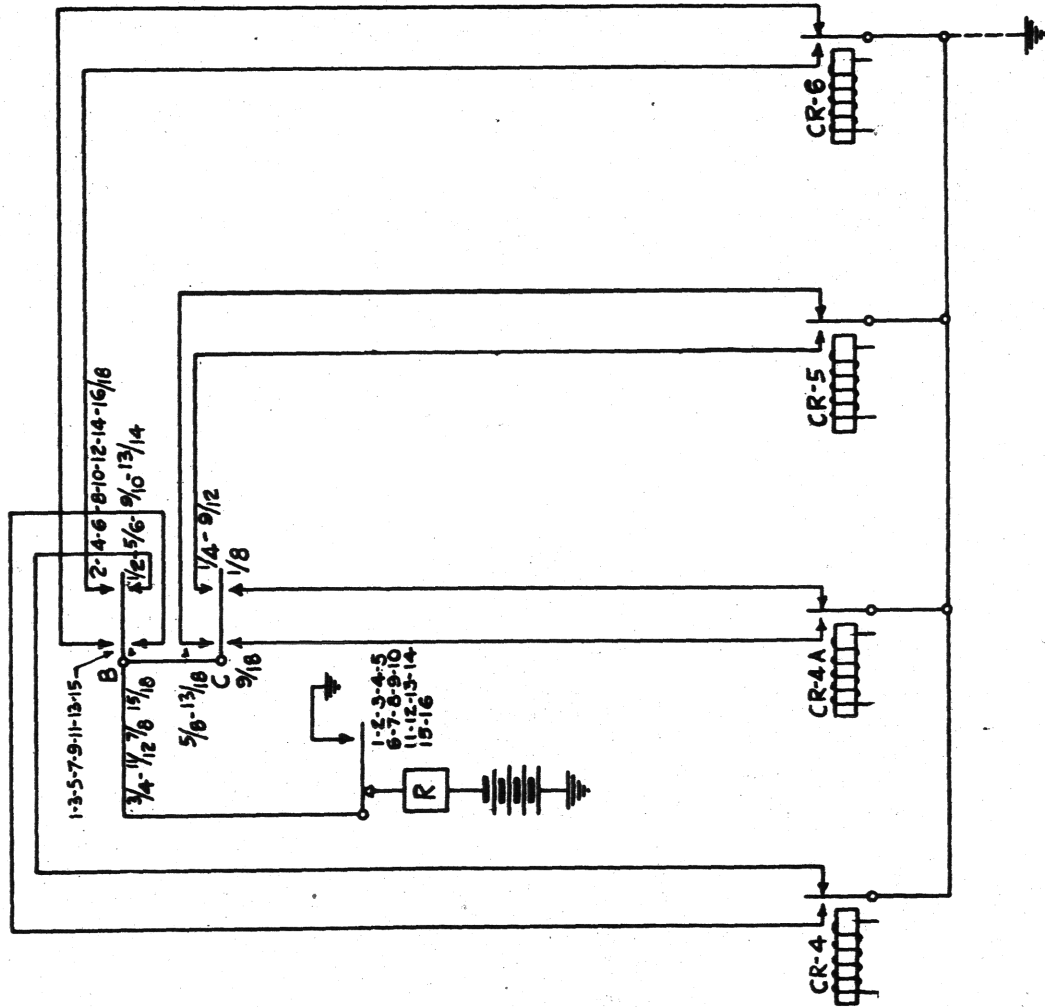
TRUNK HUNTING CIRCUIT.

	IDLE		BUSY { INCOMING CALL TO FINAL		BUSY { ORIGINATING CALL THROUGH LINE SWITCH		ISSUE # 1
	FINAL TEST CIRCUIT	LINE CIRCUIT	FINAL TEST CIRCUIT	LINE CIRCUIT	FINAL TEST CIRCUIT	LINE CIRCUIT	
DIRECT LINE OR LAST LINE OF A P.B.X. GROUP.							.030 AMP.
CURRENT THROUGH "L" AND "P.B.X." RELAY	NONE		.031 AMP.		.030 AMP.		
ACTION OF "L" RELAY	RELEASE		DOES NOT RELEASE		DOES NOT RELEASE		
ACTION OF "P.B.X." RELAY	DOES NOT OPERATE		OPERATES		OPERATES		
P.B.X. LINE OTHER THAN LAST OF GROUP							.0154 AMP.
CURRENT THROUGH "L" AND "P.B.X." RELAY	NONE		.0154 AMP.		.0150 AMP.		
ACTION OF "L" RELAY	RELEASE		DOES NOT RELEASE		DOES NOT RELEASE		
ACTION OF "P.B.X." RELAY	DOES NOT OPERATE		DOES NOT OPERATE		DOES NOT OPERATE		

FINAL TESTING CIRCUIT. PANEL TYPE POWER DRIVEN SYSTEM.

	IDLE		BUSY { INCOMING CALL TO FINAL		BUSY { ORIGINATING CALL THROUGH LINE SWITCH		ISSUE # 1
	FINAL TEST CIRCUIT	LINE CIRCUIT	FINAL TEST CIRCUIT	LINE CIRCUIT	FINAL TEST CIRCUIT	LINE CIRCUIT	
DIRECT LINE OR LAST LINE OF A P.B.X. GROUP							.030 AMP.
CURRENT THROUGH "L" AND "P.B.X." RELAY	NONE		.031 AMP.		.030 AMP.		
ACTION OF "L" RELAY	RELEASE		DOES NOT RELEASE		DOES NOT RELEASE		
ACTION OF "P.B.X." RELAY	DOES NOT OPERATE		OPERATES		OPERATES		
P.B.X. LINE OTHER THAN LAST OF GROUP							.0150 AMP.
CURRENT THROUGH "L" AND "P.B.X." RELAY	NONE		.0154 AMP.		.0150 AMP.		
ACTION OF "L" RELAY	RELEASE		DOES NOT RELEASE		DOES NOT RELEASE		
ACTION OF "P.B.X." RELAY	DOES NOT OPERATE		DOES NOT OPERATE		DOES NOT OPERATE		

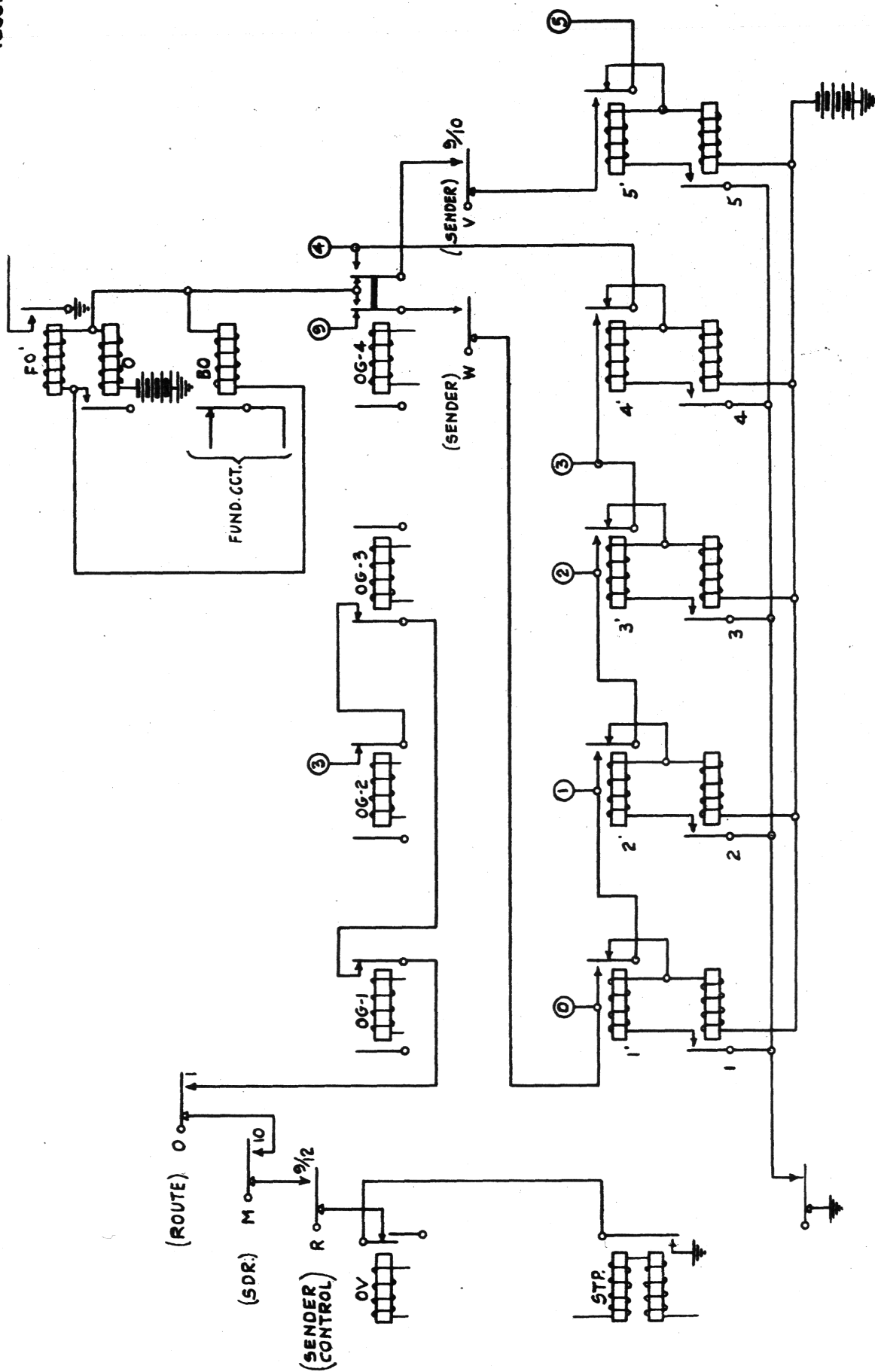
FINAL TESTING CIRCUIT.
PANEL TYPE POWER DRIVEN SYSTEM.



NOTE: ✓ INDICATES RELAY OPERATED.

	CR-4	CR-4A	CR-5	CR-6	OFFICE	RELAY STATION OFFICE
1	✓	✓		✓	1200	1200
2	✓	✓			1200	900
3		✓		✓	1200	300
4		✓			1200	600
5	✓	✓	✓	✓	1200	0
6	✓	✓	✓		900	900
7		✓	✓	✓	900	300
8		✓	✓		900	600
9	✓			✓	900	0
10	✓				600	300
11				✓	600	0
12					600	600
13	✓		✓	✓	300	300
14	✓		✓		300	0
15			✓	✓	OPEN	OPEN
16			✓		0	0

METHOD OF SETTING COMPENSATING RESISTANCE SWITCH MACHINE SWITCHING OFFICES

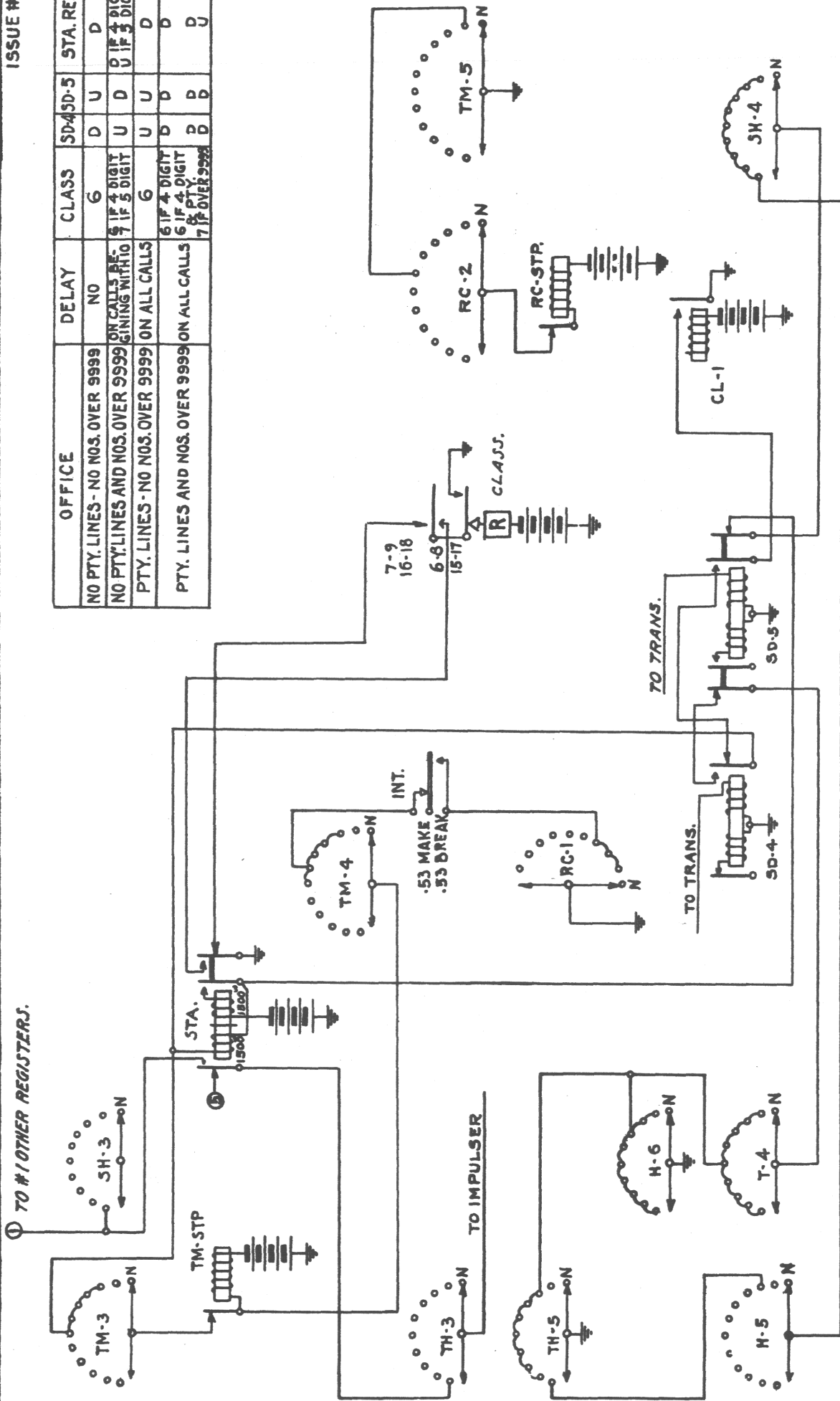


METHOD OF ADDING 5 FOR GROUP SELECTIONS MACHINE SWITCHING OFFICES

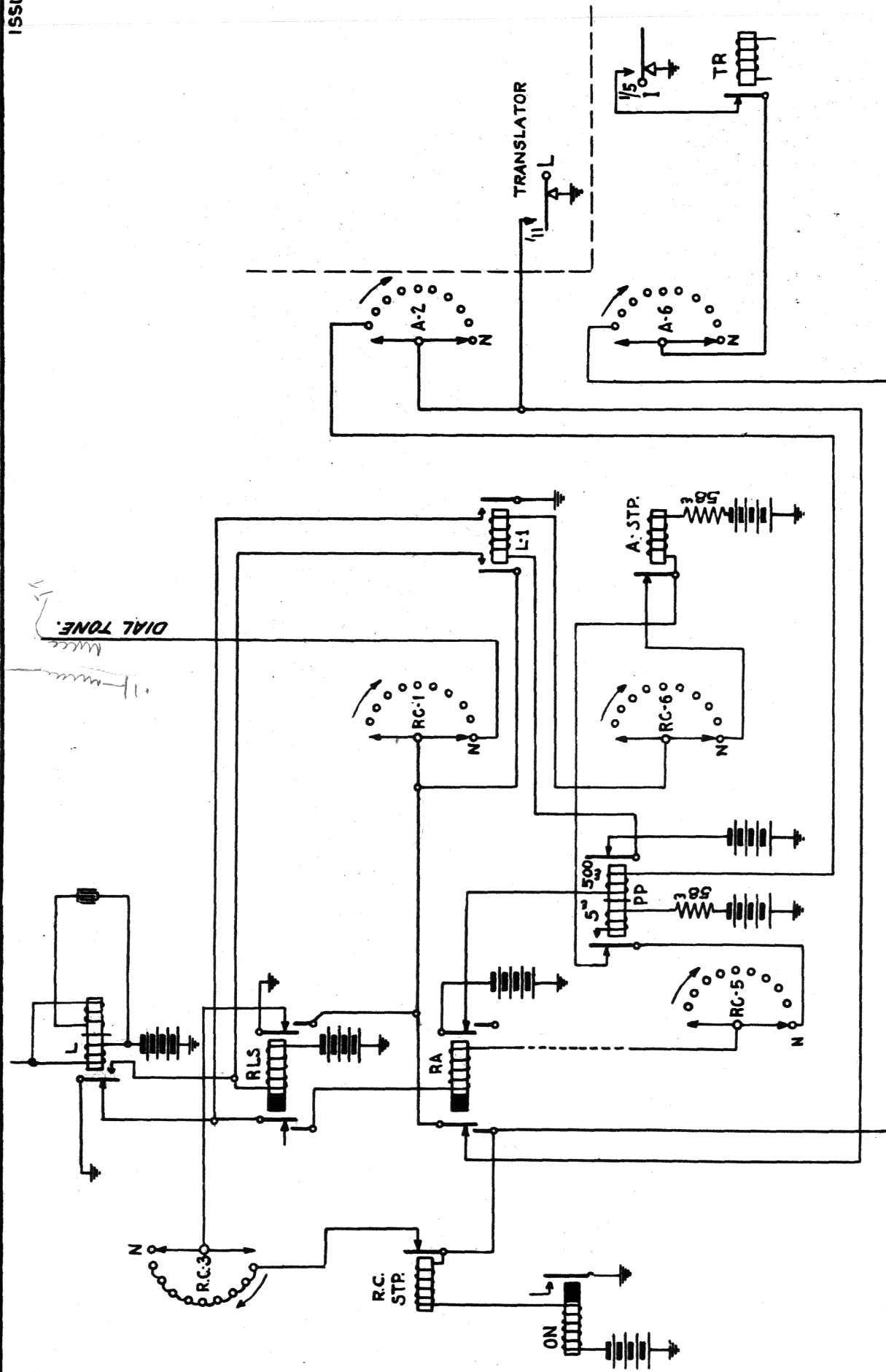
① TO #1 OTHER REGISTERS.

ISSUE # 1

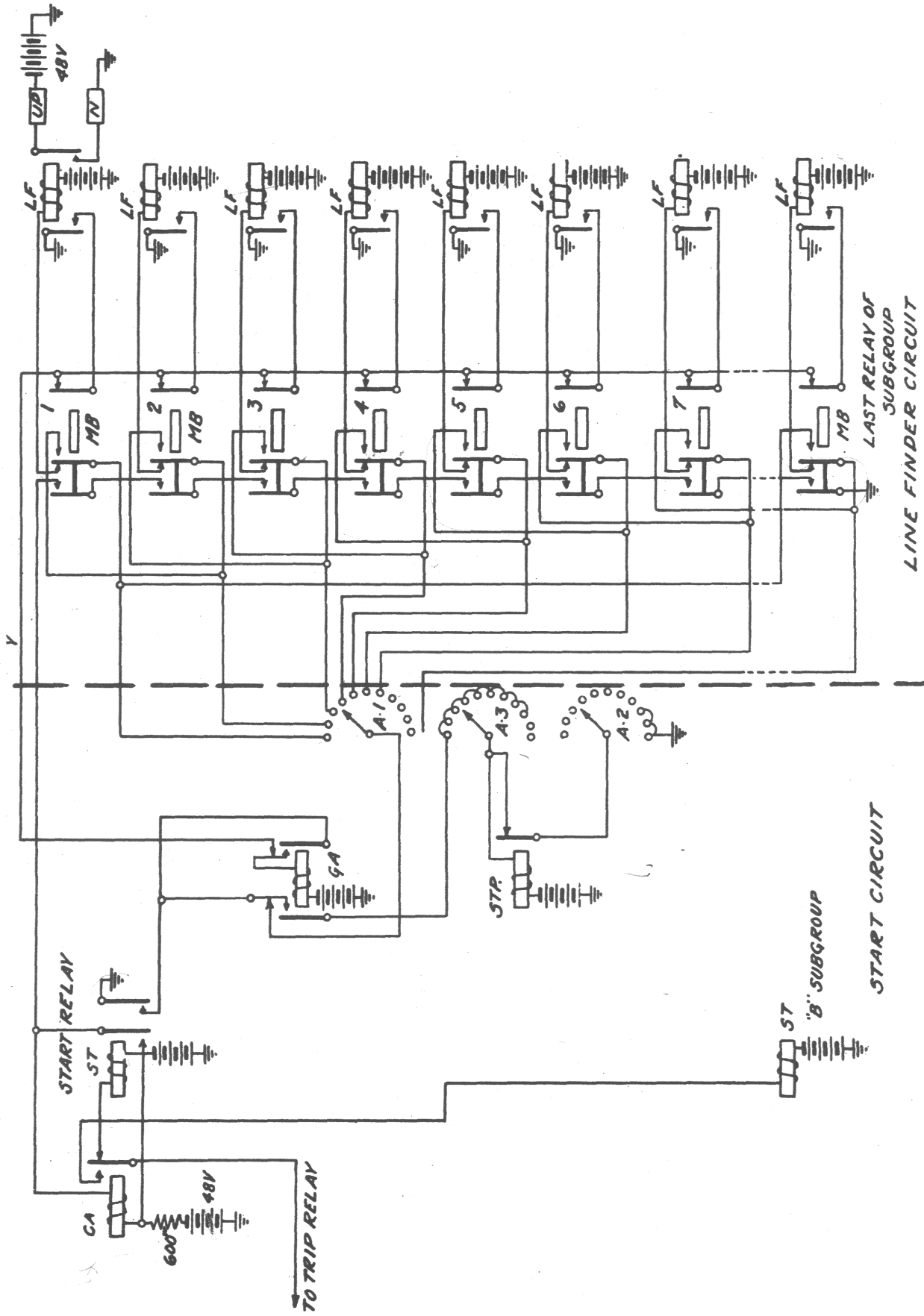
OFFICE	DELAY	CLASS	SD-4SD-5	STA. REL.
NO PTY. LINES - NO NOS. OVER 9999	NO	6	D U	D
NO PTY. LINES AND NOS. OVER 9999 ON CALLS BEGINNING WITH 10		6 IF 4 DIGIT 7 IF 5 DIGIT	U D	D IF 4 DIGIT U IF 5 DIGIT
PTY. LINES - NO NOS. OVER 9999 ON ALL CALLS		6	U U	D D
PTY. LINES AND NOS. OVER 9999 ON ALL CALLS		6 IF 4 DIGIT 6 IF 4 DIGIT 8 PTY. 7 IF OVER 9999	D D D D D D	D D D D D U



STATIONS DELAY FEATURE



DIAL AND PRELIMINARY PULSE CIRCUIT MACHINE SWITCHING OFFICES



MACHINE SWITCHING SYSTEM

FIG. 1 - DISTRICTS - LOCAL OFFICE - TWO WIRE OFFICE



FIG. 2 - WTCPT. COL. - INTER OFF. COL. - LD. COL. - LOCAL INC. - INTER OFF. INC.

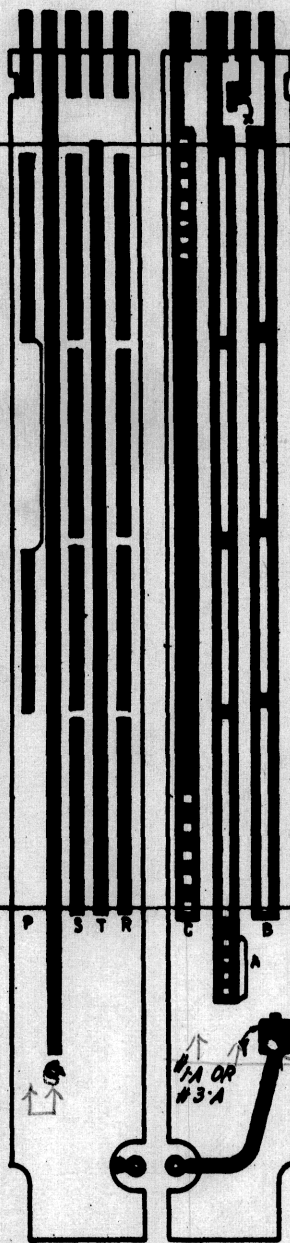


FIG. 3 FINAL

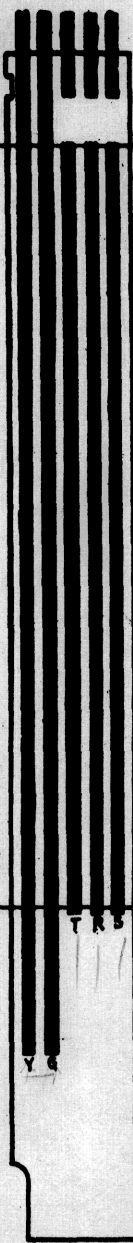


FIG. 4 SENDER SELECTOR - TRUNK FINDERS



FIG. 5 TRANSLOCATORS

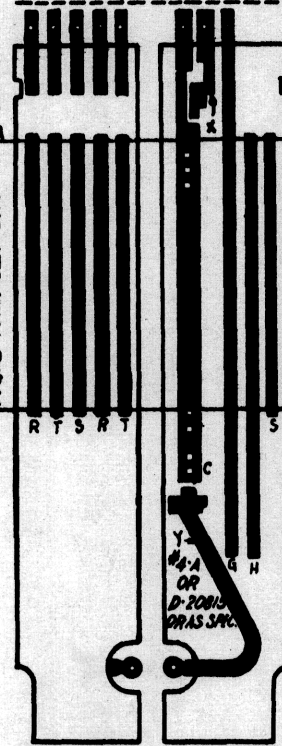
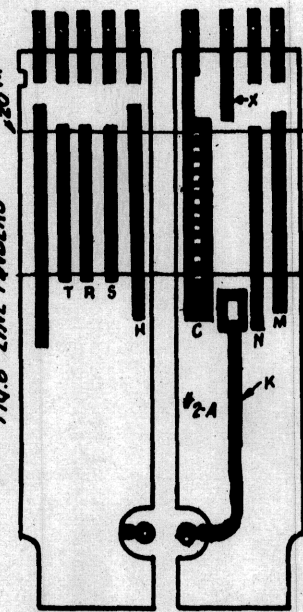
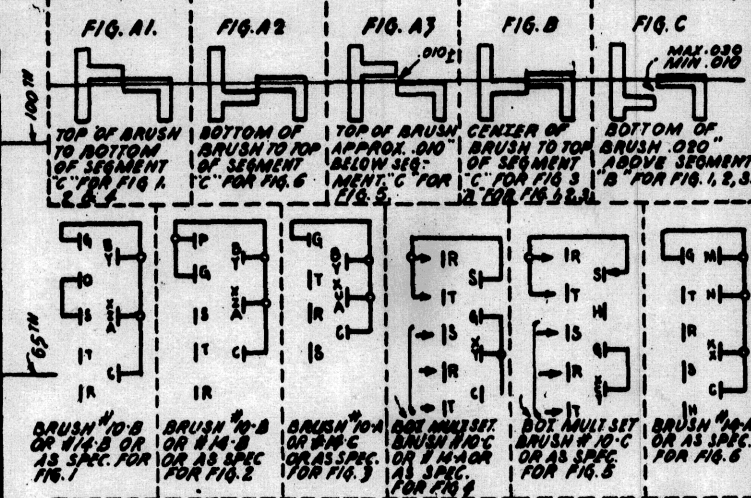


FIG. 6 LINE FINDERS



ISSUE # 1



SECTION XV

POWER DRIVEN PANEL TYPE MACHINE SWITCHING SYSTEM

DESCRIPTION OF DRIVING MECHANISM

(NOT INCLUDING POWER PLANT.)

The driving mechanism of the Power Drive Panel Type Machine Switching System consists of motors, friction rolls and drive, vertical shafts and drive also associated gear boxes and connecting shafts.

Motors

Each side of each frame, or each vertical shaft, may be provided with a driving motor, depending on the conditions involved. In some cases one motor will operate one or more sides of a frame or several vertical shafts, as described under "Friction Roll Drive and Vertical Shaft" .

The motors in any particular office will all be of one of the following types:

- (A) 1/8 H.P., 220-volts A.C.
- (B) 1/16 H.P., 48-volts D.C. - 220-volts A.C. duplex.

The duplex motor will operate on either 48-volts D.C. or 220-volts A.C., this feature eliminating the use of emergency generating units to furnish A.C. in the event of power failure, which is necessary where the A.C. type of motor is employed. This feature is outlined in detail in the descriptive matter covering "Power Plant".

Irrespective of the type used, each motor is provided with a projecting member and plug, on which the motor leads are

terminated. A receptacle corresponding to this plug is connected to the power supply by a flexible cable, extending from a switch mounted adjacent to the motor. The feet of the motor are beveled to fit the motor brackets which in turn are provided with a clamping device for securing the motor in position.

Mounted on the shaft of the motor is a face plate with projecting pins which lines up with a similar device on the drive shaft of the gear box with which the motor is associated.

Between the two face plates is a leather disc provided with holes for the projecting pins, the entire combination forming an insulated coupling.

Friction Roll Drive

The friction roll drive is the mechanism used to transmit the power from the motor to the friction rolls, which in turn operate the panel selectors by means of the racks and clutches as described in Section II.

There are two types of friction roll drive units known as the "Single" and "Two Speed" respectively, depending on whether one or two up-drive speeds are provided. The "Two Speed" type is used on final frames where a low and high speed up-drive is required. In both types, however, a down-drive is always provided. The mechanism constituting the friction roll drive is individual to one side of a frame and consists of cork covered rollers mounted at the bottom of the frame, which are terminated in a gear box at one end and a bearing box at the other.

The gear box ends are associated with each other and where driven by a separate motor, with the driving pinion carrying the insulated motor coupling, by means of gears and pinions contained within the gear box.

In cases where a separate motor is not provided for each drive unit, several in the same line up may be operated from the same source of power by means of connecting shafts between the lower rolls. These shafts are coupled directly to the ends of the lower roll shafts which are so constructed as to admit of this method where necessary.

Lubrication is accomplished by means of an oil pump contained within the gear box, which in addition to circulating the oil contained therein supplies oil to the bearing box at the other end through two copper pipes.

Vertical Shaft

The vertical shaft and its associated apparatus is the mechanism through which the sequence switches, power driven rotary switches and the interrupters are operated. The sequence switches and power driven rotary switches are operated by means of drive plates and the interrupters by gears mounted on the vertical shaft as described in Section II. These shafts are supported at intervals by means of ball bearings contained in brackets.

The lower end is provided with a gear and thrust bearing contained within a gear box; the gear being associated with other gears contained therein.

Vertical shafts may be terminated as follows:

- A..In the gear box associated with the friction rolls.
(See friction rolls.)
- B. In separate gear boxes operated by separate motors.
- C. In separate gear boxes, several of which are operated from the same motor. In this case the boxes are tied together by means of connecting shafts, the method being essentially the same as that employed for the friction roll drive units.

The gear box in "A" is described under "Friction Roll Drive".

The gear box in "B" and "C" is essentially the same except that a less number of gears are used, due to the fact that no rolls are to be operated. The lubrication in this case is accomplished by means of oil contained in the box which is carried to the bearings by the action of the gears.

Under ordinary conditions no lubricant is used on the vertical shaft ball bearings. Exceptions to this rule are outlined in the section on "Lubrication and Cleaning of Driving Mechanism".

REPLACING POWER DRIVE APPARATUS

The instructions following cover in detail the method to be followed in replacing various parts of the machine switching apparatus, also the tools used in connection with these replacements.

Sequence Switch

The parts of a sequence switch which can be changed separately are as follows:-

"R" Magnet

Spring

Cams

To Remove "R" Magnet

Make circuit which includes the sequence switch busy.

Unsolder the wires from the "R" magnet terminals.

Loosen the two screws on the back edge of the inside plate which fasten the magnet to the sequence switch frame, using an offset screwdriver from the rear of the frame.

Remove two front screws attaching the magnet to the frame.

The magnet can now be removed from the frame.

Mounting an "R" Magnet

See that the rear screws on the frame are out far enough to allow the magnet plate to slip under the heads.

Place the magnet in position with the bent coil plate down and place the two front screws in the frame through the magnet plate.

Tighten up on these screws, being careful to see that the bent plate is parallel to the drive plate on the vertical shaft and in accordance with standard requirements.

Solder the wires on the "R" magnet terminals.

To Remove Spring Nests

Make circuit busy and remove fuses.

Unsolder wires at the brush terminals of the nest to be removed.

Remove the screw and washer from the rear of the sequence switch frame holding the nest.

Lift the nest out of the cam assembly from the front of the frame.

Place Spring Nests

Tighten the assembly screws of the nest with the springs parallel. Place the spring nests above the cams with the spring entering in front of and parallel with the cams and with the terminal end toward the rear.

Slightly spread the springs so that they can be placed on the cams at the same time; push the nest towards the back of the frame. The nest will come to rest at the proper place when the rear of the frame is reached.

Fasten in place from the rear with the screw and washer provided. The spring nest should be centered horizontally before tightening the screw.

Adjust springs in accordance with standard practice.

Solder the wires on the spring terminals.

To Remove Cams

Make circuit busy and remove fuses.

Loosen clamping screw on right end of switch frame.

Hold assembled cam shaft in the left-hand and pull the bearing out a little to the right.

Move assembled cam shaft to the right enough to have the left end of the cam shaft clear the left bearing.

Draw the cam shaft assembly with cams and plate away from the springs.

Mount cam shaft assembly in No. 225 tool and clamp the driven plate at a convenient point, preferably so that the straight edge may be placed opposite the edge of a cutting on a cam to be retained on the shaft which corresponds to a similar cutting on the new cam or cams to be added.

Mark reference line on edge of cams with No. 240 tool.

Unscrew cam clamping nut with No. 236 tool while holding index wheel with No. 203 tool.

Remove cam shaft assembly from No. 225 tool and remove clamping nut holding cams and collars in place. Hold cam shaft vertically over tip of No. 258 tool and transfer cams and collars to spindle until cam to be removed is transferred being careful to retain removed cams in alignment on spindle.

Make change of cams on spindle of No. 258 tool being careful to arrange cams so that the letters stamped on the cutting shall be in alignment and that all rivet heads will be toward the index wheel end when assembled.

Transfer the necessary cams from spindle to cam shaft preserving the cam alignment in the process. Add necessary washers and index wheel in proper position on shaft and thread clamping nut on shaft.

Mount cam shaft assembly in No. 225 and rotate it to center spacing collars on shaft. Clamp shaft at convenient point and bring marked cams into alignment by bringing scriber marks to the straight edge on No. 225 tool. Bring previously chosen edge of cutting on new cams into alignment on straight edge if possible in this position of cam shaft or align new cams by reference along straight edge to marked cams having cuttings in some position which corresponds to cutting on new cam.

Tighten cam clamping nut using No. 203 and No. 236 tools as before. Check alignment of cams before removing cam shaft from No. 225 tool.

Place the assembled cam shaft with cams under the springs and turn the whole towards you at the same time raising the left end of the assembly so that the cams enter between the springs and permit the left end of the shaft to slip into the left bearing. Continue turning the shaft and raise the right end until all cams have entered between their proper springs and then push the right bearing into the end of the shaft. Adjust end play per section on adjustment.

Inspect all cams and springs as described in section on "Inspection and Adjustments."

CLUTCH CHANGES

It is necessary sometimes to remove the clutch in order to make certain adjustments and inspections.

To Remove a Clutch

Make the selector busy by means of a make busy plug inserted in the make busy jack for the particular selector.

Raise the selector as far as possible and support it by a wire hook to the bearing plate between the two lower banks.

Unhook the rack coupling from the brush rod and operate the down drive manually until the rack is low enough to clear the bottom of the rod.

Remove the rack by lifting it out from behind the clutch.

If the clutch is to be taken away the wires at the bottom terminal should be unsoldered and laid back carefully.

Loosen the large screw near the bottom of the clutch.

Lower the clutch until the two projections at the top are clear of the holes in the clutch top locating plate.

Pull the top of the clutch away from the frame until it is clear of the plate and then lift up. The clutch should be clear.

To Replace a Clutch

The brush rod is held up by the wire hook at the bearing plate between the two lower banks. Loosen the large screw on the bottom cross bar at the location where the clutch is to be placed.

Lower the clutch so that the head of the screw-slips over the slot at the bottom of the clutch and the top of the clutch is slightly lower than the clutch top mounting plate.

Push the clutch in towards the frame until the projections at the top are in far enough to slip into the holes in the clutch top mounting plate when the clutch is lifted.

See that the clutch is evenly spaced between adjacent clutches and up firmly against the bottom of the mounting plate and then tighten the bottom set screw.

Start the rack in at the top of the clutch and operate the down drive clutch manually being careful to guide the rack from the top so that it will be in its proper location.

To check the vertical alignment of the clutch raise the rack to the bottom of the brush rod and swing the rack from side to side to determine if the rack coupling will at least line up with the outside surface of the brush rod within the limits of side play of the rack in its guides. If the coupling pin and brush rod cannot be aligned in this manner without binding loosen the clutch mounting screw and shift the bottom of the clutch to meet this requirement. Then couple the rack to the brush rod.

Remove the wire hook holding up the brush rod and operate the down drive clutch manually.

Check "C" commutator brush for vertical location on lower, central and upper line terminals.

COMMUTATOR CHANGES

To Remove The Commutator

Make selector busy by inserting make busy plug in make busy jack for the particular selector.

Unsolder wires on terminals at top and bottom of commutator. Care should be exercised as the insulating composition of the commutator will melt if too much heat is applied to the terminal.

Remove clip at top commutator plate holding the commutator in place.

Lift up commutator out of bottom commutator plate.

Hold top of commutator with one hand and pull out away from the frame and up out of the commutator brushes; at the same time lift the brush springs up and over the segments of the commutator with the other hand. Care should be taken to not bend the brush rod or commutator brush contact springs.

To Place A Commutator

The selector is made busy and the clip at the top commutator mounting plate removed.

Place the commutator in the commutator brushes. The proper way is to hold the commutator in the right hand with the terminal end up and the side with the feeder bars to the left. Pull the brush rod out a little, away from the frame and with the bottom end of the commutator, spread the commutator brushes a little and then insert the commutator into the brushes. The

commutator should be straightened with relation to the brush rod and at the same time inserted into the bottom mounting plate. It is necessary to push the commutator back against the tension spring before attempting to slip the bottom end into the slot. The brush springs should be guided by the hand to avoid bending during this operation. The top of the commutator should be pressed against the back of the slot in the top plate so that the locating slot in the rear of the commutator will engage the plate properly.

Attach the fastening clip to the top mounting plate.

Solder the wires to the terminals at the top and bottom of the commutator. Care should be exercised as the insulating composition of the commutator will melt if too much heat is applied to the terminals.

Check the "C" commutator brushes on the upper, central and lower line terminals for vertical centering.

CHANGE COMMUTATOR BRUSHTo Remove the Commutator Brush

Unsolder the wires on the brush and pull out in line with the brush rod.

Loosen clamping screw with tool No. 220 on the front of the brush holder.

Raise brush holder off of brush rod and extend wires.

Unless the commutator has already been removed, the commutator will have to be removed but is only unsoldered at the bottom so as to slip the brushes being removed off the lower end of the commutator.

To Place the Commutator Brush On The Brush Rod

Provided the commutator is not removed, the brushes should be placed on the commutator by removing the commutator and slipping the brushes on the lower end. (See Commutator Changes)

Thread the wires from the end of the brush rod through the clamp of the commutator brushes and then pass the brush rod through the clamp. Tighten the clamp and re-solder the wires to the brush terminals.

Check centering of "C" commutator brush on lower, central and upper line terminals and also other brushes if a new set of brushes is installed.

CHANGE MULTIPLE BRUSH

To Remove a Multiple Brush

Make selector busy.

Raise the brush rod until the brush to be removed is approximately midway between the brush rod bearing plates.

Unsolder the wires at the brush terminals.

Loosen screws which fasten brush clamp to brush assembly.

Hold the brush with the left hand, and loosen the screws with the No. 220 tool in the right hand. The brush assembly can then be turned up and removed from behind the brush rod. The right pair of contact springs will have to be spread a little further from the center of the brush assembly to allow the trip rod to pass out of the brush.

To Place A Multiple Brush

Remove the clamp from the multiple brush to be placed. Do not trip the brushes.

Raise the brush rod until the portion of the rod on which the brush is to be mounted is approximately midway between bearing plates.

Pass the brush assembly to the left of the brush rod and in back on a horizontal position with the two right springs spread away from the spreader so that the trip rod may be passed into the assembly.

The brush assembly can now be brought down in line with the multiple bank and the clamp attached to hold the brush approximately centered.

- 11 -

Solder the wires to the brush terminals. The proper colors can be ascertained by referring to any brush, on the same or adjacent rods.

Move the brush rod so that the pawl in the clutch is in the rack slot #0. Adjust the multiple brush in accordance with standard practice.

CHANGE SELECTORS

This covers the changing of the part of the selector known as the brush rod and trip rod. They may be changed separately or together, although it is advisable to remove both when it is necessary to change either.

Remove Brush Rod and Trip Rod

Make selector circuit busy.

Raise the brush rod by hand and uncouple the rack.

Remove back.

Lower brush rod and clamp the brush rod to the trip rod, using the clamp provided.

Loosen the clamp screw for each bearing plate and remove the bearings.

Detach the small tension spring at the bottom of the trip rod.

One man at the top loosens the commutator holding clip, unsolders the wire at the lower end and pulls the commutator out far enough to allow the commutator brush to slide off the lower end of the commutator when the other man lifts the rod up and out far enough to clear the clutches when it is necessary to lower the rod away from the commutator.

The commutator is put back temporarily and the rod lowered carefully down to a horizontal position. The clamp can be removed and the trip rod drawn out of the brush rod. Avoid snagging brushes during this operation.

Place Brush Rod and Trip Rod

The brush rod and trip rod should be clamped together in approximately their normal relative positions. The German silver bearings should be removed and the commutator loosened enough to be easily removable.

Lift the rods to a vertical position with one man up on the ladder holding the top, and the other man on the floor steadying the rod.

Separate the commutator brush springs with the bottom end of the commutator and slip the brush up the commutator about halfway after inspecting to see that the commutator brush springs are on the segments.

Place the commutator in its lower plate and allow the rods to fall into the bearing plates. Fasten the commutator in place and solder in the bottom wire.

Place the German silver bearings and see that the lower end of the trip rod is in the hole in the bottom plate; attach the tension spring.

Remove the assembly clamps, place the rack in the clutch and couple to the brush rod. Adjust according to standard practice.

TO REMOVE A MULTIPLE BANK

Take frame out of service and stop drive motor.

Unsolder leads, simultaneously at each end and on each side of bank if possible.

Mount and adjust bank resetting gauges #61 (see "Detailed Instructions for the Use of Gauge #61" accompanying the instructions, "To Replace a Multiple Bank").

Ascertain the direction in which the bank can be removed with the least interference to the cabling and the frame apparatus. The end of the bank which clears the selectors first in the process of removal will hereinafter be referred to as the "leading end," the opposite end, the "trailing end."

If necessary cut cable stitching on bank cabling sufficiently to permit the passage of the bank.

Loosen bank mounting screws, but do not disturb screw bushings during entire operation of bank removal and replacement.

Remove bank levelling screw at trailing end and attach bank removal guide, tool #237.

Remove upper mounting screw at trailing end and attach multiple bank carrier, tool #230.

Remove all bank mounting screws, the bank being supported manually at each end.

Remove bank by sliding with guide on Tee cross-member, the man at the trailing end guiding the bank to prevent injury to brushes and selector rods while man at leading end pulls bank

thru. Note: It may be necessary to suspend operations with the bank partially removed to attach a second carrier to the first in order to lengthen it.

TO REPLACE A MULTIPLE BANK

The new bank must be of the same type as the removed bank and must be inspected for horizontal and vertical bows and other defects before being mounted.

Remove guide from removed bank and attach to leading end after having determined which end of bank should enter between the selectors first if bank has front and rear sides.

Mark 50th terminal at each end on side of bank which is to face the resetting gauges.

Attach one or two carriers as necessary on leading end of bank and raise bank to proper height and start sliding into position between selectors placing guide on Tee cross member.

When opposite mounted position remove carrier and start upper mounting screws.

Remove guide, start lower mounting screws and approximately locate bank with its levelling screws.

Adjust position of bank to that of removed bank as indicated by the resetting gauges (see "Detailed Instructions for the Use of Gauge #61"),

Tighten mounting screws.

Tighten locknuts on levelling screws.

To check location of bank to discover possible horizontal or vertical bowing due to mounting raise selectors 1, 29, 59 and 2, 30 and 60 successively to lower, central and upper

bank terminals and determine if the brushes when tripped project in from the end of the terminals not less than half the width of the fibre shoe and not more than the full width of the fibre shoe.

When the bank is satisfactorily located and checked, connect the bank cabling to the terminals.

DETAILED INSTRUCTIONS FOR THE USE OF GAUGE #61

The object of this gauge is to obtain two fixed points of a mounted multiple bank with reference to the brush supports assembled in the frame so that the bank can be removed and later on placed again in its former position, or replaced by a new bank, by means of the reference points previously established. In a hundred line bank these two points are usually the 50th terminals of the extreme right and left hand vertical rows of terminals.

The gauge is furnished in sets of two, both of them alike, which can be used interchangeably on either right or left hand side of the bank with this difference, however, that the locating plug of the left hand gauge will be in a top position and of the right hand one in a bottom position.

Referring to the Assembly drawing No. 10854, it will be seen that the gauge is held in front of the multiple bank by two screw clamps, Det. 3. The clamps are normally spaced six brush supports apart but provisions are made to shift one of the clamps to the center of the bar, Det. 1, thereby clamping on two adjoining pairs of brush supports. This makes the gauge

available for partially equipped frames having a minimum of four brush supports. Also the center position may be used for a third clamp in case it is found that this adds to its rigidity when placed in position on a fully equipped frame.

To prevent interference with the multiple bank terminals while the gauge is being placed in position on the brush supports the locating plug, Det. 8 is drawn back against its stop pin and held there by the set screw, Det. 7.

The sliding head composed of Dets. 4 and 5 should now be locked to the base, Det. 1 by the locking screws, Det. 12, operating through the sleeve, Det. 6, spring Det. 10, and 3/4" washer. Then release screw about a half turn from its full clamping position so that the sliding head is now held against the base by the pressure of the spring and can be set by means of the knurled head adjusting screws, Dets. 2 and 9 to an approximately central position permitting an equal amount of adjustment in all directions.

The gauge is then moved vertically along the brush supports until the end of the locating plug, when pushed forward, comes approximately within the space between the 50th and 51st terminals in the case of a hundred line bank or the center terminals of any bank. It is then clamped in position.

To make the final vertical adjustment slide the locating plug in its bearing to a point where the end is approximately .010" off the ends of the terminals and hold there by the set screws. Then shift the sliding head by means of the knurled head

adjusting screws to such a position that, when the brush supports are sprung forward by hand, the small end of the locating plug will enter freely between the two center terminals.

Final horizontal adjustment is now obtained by sighting along the row of terminals among which the plug has entered. Since the diameter of the small end of the plug corresponds to the width of the terminals the coincidence of the two can be readily determined. It is necessary, however, that when this reading is taken the plug is held in position by the set screw. Otherwise the clearance between the plug and the bearing would permit enough play to make the adjustment certain.

Next, the vertical plane of the bank is fixed by adjusting the locating nut, Det. 16, to a stop against the sliding head at a point where the shoulder of the locating plug just rests on the ends of the two terminals between which the reduced portion of the plug has entered. Apply as little pressure as possible to avoid springing. Lastly the check nut, Det. 15, is locked against the locating nut.

The locating plug is prevented from turning on account of its key-way engaging with the reduced end of the set screw acting as a key. This permits the nuts to be set up without turning the plug, but care should be taken not to screw the check nut down too hard as it has a tendency to draw the plug back from its position on the terminals of the multiple bank.

A final check should be made by drawing the locating plug back and then bringing it forward again to a stop. Clamp in this position and test by slightly springing the brush supports

whether the shoulder of the plug is resting on the terminals same as before.

After locating the second gauge on the opposite end of the bank in the same manner the two locating plugs are drawn back against their stop pins and held there by the set-screws. The bank can now be removed.

It is obvious that the gauges must not be disturbed in any way during the removal and the placing of a bank to an approximate position in the frame.

The resetting of a bank is the reverse process of that used in locating the gauge. The bank is shifted until, when the locating plug is pushed forward to a stop, the corresponding two center terminals will permit the small end of the plug to enter and satisfy all the conditions that were determined in the original setting of the gauge.

TO REMOVE A FRICTION ROLL DRIVE

Take the side of the frame containing the defective roll and all the sides of frames driven by the motor which drives the defective roll out of service.

Stop motor, and remove it if necessary.

Take down connecting shafts, if any.

Drain oil from gear box and bearing box supporting defective roll.

Remove feed and return oil tubes.

Remove gear case cover.

Remove gears off end of roll shafts.

Uncouple sequence switch drive shaft coupling and remove it.

Unclamp upper pivot screw on gear case by loosening locknut next to gear case and back off pivot screw sufficiently to allow gear case to be removed.

Unclamp upper pivot screw on bearing box by loosening locknut next to bearing box and back off pivot screw sufficiently to give the bearing box the amount of play required in manipulating the rolls during their removal.

Lift gear case off its pivot screws while the rolls are held and supported by an assistant to prevent the rolls from dropping at the gear case end and from sliding out of the bearing box at the other end.

Slide gear box off the end of the roll shafts.

Insert wooden strips ($3/4"$ x $1-7/8"$ x $36"$) under each roll locking up the lower strip at each end with blocks measuring $1-1/2"$ x $3"$ and tapering from $3/4"$ to $1/8"$ in thickness set on edge.

Each roll is now slid out of bearing box care being taken to prevent cork surface from snagging on clutches and guard plates. Roll guard plates prevent the rolls being removed interfering with rolls on the side not being worked upon.

Remove bearing box.

Immediately upon removing the gear case covers, etc. of as soon thereafter as convenient, the sealing material upon the surfaces of the broken sealed joints should be removed by washing it off with carbona. The Special Pipe Joint Paint used for sealing, when exposed to air dries very rapidly, and since the material between the sealed surfaces may not be thoroughly dried out, time can be gained by cleaning it off at the first opportunity. When ready to reassemble the dismantled parts should be thoroughly cleaned and bearing surfaces lubricated.

TO REPLACE A FRICTION ROLL DRIVE

Move bearing box loosely on its pivots.

Slide the bearing box end of each roll into bearing box.

Insert wooden strips ($3/4"$ x $1-7/8"$ x $36"$) under each locking up the lower strips at each end with blocks measuring

1-1/2" x 3" and tapering from (3/4" to 1/8") in thickness.

Slide gear box on end of roll shafts and mount on its pivot screws.

Tighten pivot screws and clamp them with the locknuts.

Attach sequence switch drive shaft coupling to vertical shafts and couple them together.

Mount the gears on the roll shafts.

Apply a moderately liberal and even coat of the Special Pipe Joint Paint with a small brush on the joint surfaces of both the gear case and its cover immediately before assembling the gear case. This method also applies to sealing the pump casing on the bottom of the gear cases.

Assemble the gear case cover and immediately tighten the clamping screws while the Joint Paint is still wet. Assemble the pump case in like manner.

Note When assembling the upper cover it should be set to a uniform clearance around the protruding roll end. At the worm end of a drive the upper and lower covers should be set at the same time taking the precaution regarding the clearance around the roll end and aligning the worm spindle true with the motor shaft or to the gauge used for setting the motor bracket.

Care should be taken in the assembly of the pump casing to see that the gears are not cramped. This can be felt by turning the vertical shaft by hand.

Clean the oil feed and return tubes by washing with carbona and assemble them. When drawing up the coupling nuts which hold the tubes in place, only sufficient force should be applied

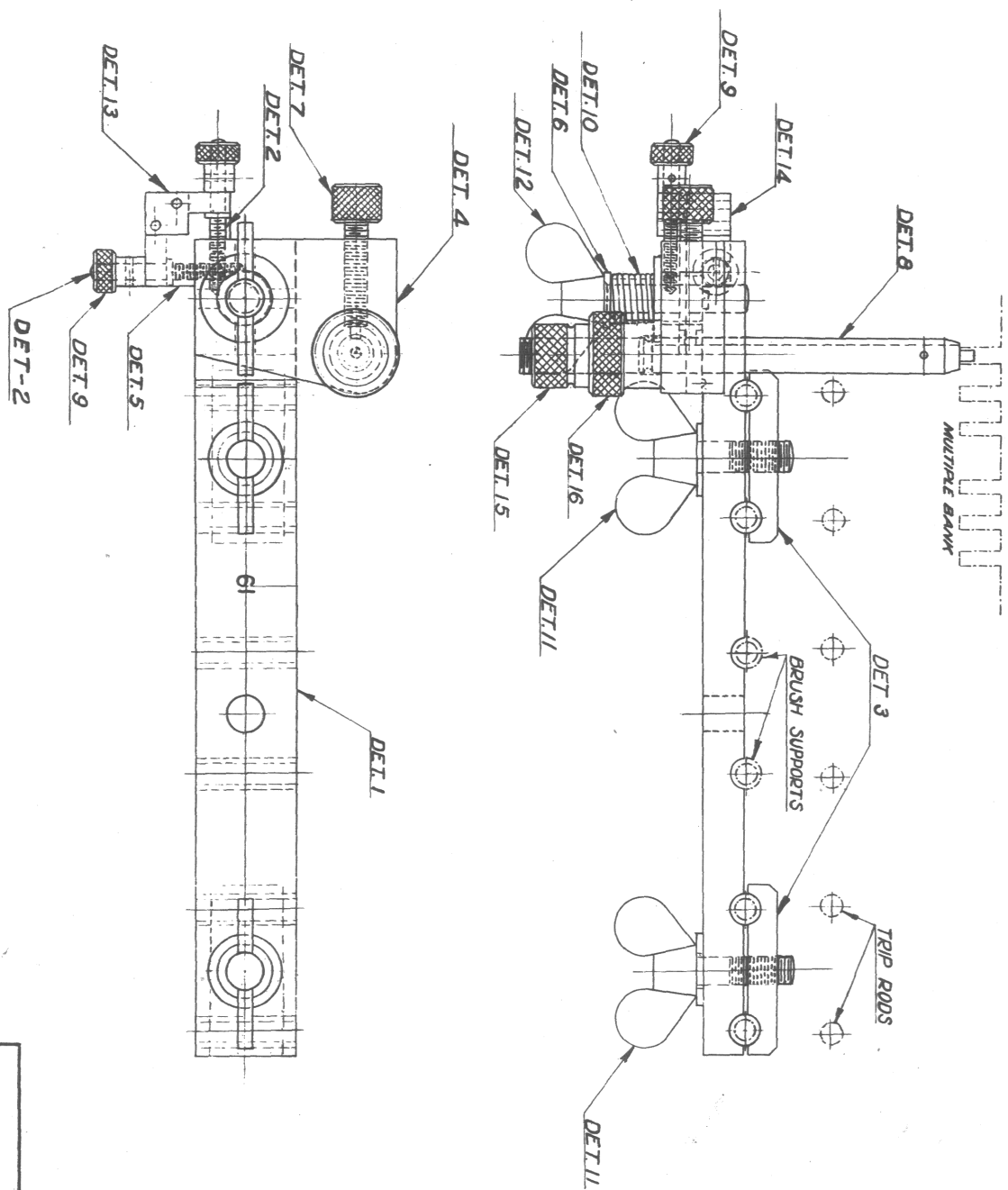
to bring the parts up snug - too much pressure is likely to overstrain the tubes and may cause a leak.

Assemble connecting shafts, if any.

Attach motor to frame and plug in current leads.

Pour oil P-2030 (Standard Oil Co. of New York) or its equivalent, into the gear case through the filling hole in the top of the gear case. When idle the normal level is within 1/8" of the top of the gauge glass, and will drop the middle of the glass when running.

Start motor and allow drive to run for a few minutes and observe oil level. When first run after being filled with fresh oil it may happen that the oil level will fall below the middle of the gauge glass due to the oil pipes not filling until the pump was started. In this event the oil level should be brought up to the middle of the glass while running by adding more oil.



RE-SETTING GAUGE #61
FOR MULTIPLE BANKS

STANDARD TOOLS

Panel Type Machine Switching Offices.

The following is a list of tools used in the maintenance of Machine Switching offices.

This includes tools which are special for this type of equipment, as well as certain of those which are also used in manual practice. In each case the name and code number is given together with the type of equipment in connection with which the tool is used.

Tools for Use on Relays

<u>Name of Tool</u>	<u>Code No.</u>	<u>Used on</u>
Armature air-gap adjusting gauge	Gauge #64-A ✓	Flat type relays
Armature air-gap adjusting gauge	" #66-A ✓	" " "
Relay spring tension gauge(50 gram)	" #70	" " "
Off-set screw driver (30°)	Tool-#206 ✓	" " "
Off-set screw driver (90°)	" - #207 ✓	" " "
Wrench for stud nut (3/16" hex.)	" , #231 ✓	" " "
Relay contact clip	" , #252 ✓	" " "
Spring adjusting tool	" , #259 ✓	" " "
Wrench for pivot screw nut(7/32"hex.)	" - #208 ✓	Stepping " "
Contact air-gap gauge (.003"- .004" - ,005"- .006")	Gauge #74-A ✓	#208 Type Relays
Armature air-gap gauge (.018"- .022")	" #73-A ✓	" " "
Armature air-gap gauge (.007"- .008")	" #73-B ✓	" " "
Armature Spring Lug & Contact Lug Ad-juster	Tool-#264 ✓	" " "
Screw driver	" , #35 ✓	Nos.114,124,198 & 207 Relays
Air-gap adjusting gauge (.034")	Gauge #41 ✓	No. 114 "
Air-gap adjusting gauge (.015")	" #42 ✓	Nos.117,198,203 & 207 Relays
Wrench, relay mounting socket (3/8"	Tool-#102 ✓	Nos.114 & 124 Relays
Spring adjusting tool	" #50 ✓	Nos.149,162 & 178 Relays
Spring adjusting tool	" #98 ✓	Nos.177 & 203 Relays

Tools for Use on Relays cont'd.

<u>Name of Tool</u>	<u>Code No.</u>	<u>Used on</u>
Wrench, combination relay adjusting (5/16" hex.)	Tool #219 ✓	Nos. 114, 124, 198 & 207 Relays
Wrench, combination relay adjusting (3/16" hex.)	" #220 ✓	Nos. 114, 124, 198 & 207 Relays
Extractor, message register cap	" #90 ✓	Message register
Contact burnisher	" #265 ✓	All Relays
Adjusting tool	" #212 ✓	Nos. 206-B & 209-A Relays

Tools for Use on Sequence Switches

<u>Name of Tool</u>	<u>Code No.</u>	<u>Used on</u>
Cam Aligning Fixture	Tool #225 ✓	Sequence Switches
Cam Aligning Scriber	" #240 ✓	" "
Cam Clamping Nut Wrench	" #236 ✓	" "
Cam Cleaning Tool	" #239 ✓	" "
Cam Notching Checking Gauge for 18 Position Cams	Gauge #45 ✓	" "
Cam Notching Checking Gauge for 20 Position Cams	" #63 ✓	" "
"A" Cam Roller Spring Tension Gauge	" #62 ✓	" "
"A" Cam Roller Spring Adjusting Tool	Tool #215 ✓	" "
"A" Cam Short Circuiting Tool	" #218 ✓	" "
Spindle for Sequence Switch Cams	" #258 ✓	" "
Sequence Switch Spring Contact Shoe	" #250 ✓	" "
Sequence Switch Spring Contact Breaker	" #267 ✓	" "
Sequence Switch Brake	" #253 ✓	" "
Driven Disc Clamping Nut Wrench	" #47 ✓	" "
Brush Spring Adjusting Tool	" #235 ✓	" "
Brush Spring Adjusting Tool	" #256 ✓	" "
Spring Tension Gauge (70 grams, for universal use)	Gauge #68	
Holding Tool for indicating Wheel	Tool #203	" "
.020" Thickness Gauge (Max. Air-gap between Driving Discs)	Gauge #55	" "
.010" Thickness Gauge (Air-gap be- tween Pole and Driving Disc.)	" #53	" "
*.025" Thickness Gauge (Min. Gap between Driven Disc & Switch Frame)	" #56	" "
*.035" Thickness Gauge (Max. Gap between Driven Disc. & Switch Frame)	" #71	" "

* Also used on clutches.

Tools for Use on Clutches

<u>Name of Tool</u>	<u>Code No.</u>	<u>Used on</u>
.015" Thickness Gauge (Min.Gap Bet.Adjusting Screw & Roller Lever, Down Drive)	Gauge #54 ✓	Clutches
.025" Thickness Gauge (Max.Gap Bet.Adjusting Screw & Roller Lever, Down Drive) (Min. Gap bet. Adjusting Screw & Roller lever, Up Drive)	" #56 ✓	"
.028" Thickness Gauge. (Min.Gap Bet. bent end of Armature & Core, Trip Magnet)	" #57 ✓	"
.035" Thickness Gauge (Max.Gap Bet.Adjusting Screw & Roller Lever, Up Drive)	" #71 ✓	"
.052" Thickness Gauge. (Max.Gap Bet. bent end of armature & Core, Trip Magnet)	" #58 ✓	"
.093" Thickness Gauge. (Min.Gap Bet. non-freezing disc on Armature & Core Trip Magnet)	" #59 ✓	"
.125" Thickness Gauge (Max.Gap Bet. Non-freezing disc on Armature & Core, Trip Magnet)	" #60 ✓	"
.122" Rod Gauge. (Min.Gap Bet. back stop and Armature, Down Drive)	" #49 ✓	"
.138" Rod Gauge. (Max.Gap Bet. Back stop and Armature, Down Drive)	" #50 ✓	"
.162" Rod Gauge. (Min.Gap Bet. back Stop and Armature, Up Drive)	" #51 ✓	"
.178" Rod Gauge. (Max.Gap Bet. back stop and Armature, Up Drive)	" #52 ✓	"
.016" & .022" Double ended thickness Gauge (Min.& Max. Air-gap, Up Drive Armature)	" #46 ✓	"
Wrench, for Adjusting Armature Spring	Tool #222 ✓	"
Pawl trip lever Adjusting Tool	" #223 ✓	"

* Also used on Sequence Switches.

Tools for Use on Multiple Bank,
Multiple Brushes & Commutator Brushes.

<u>Name of Tool</u>	<u>Code No.</u>	<u>Used on</u>
Carrier for removing & replacing Bank	Tool #230 ✓	Mult. Bank
Gauge for resetting Banks	Gauge #61 ✓	" "
Guide for removing & replacing Banks	Tool #237 ✓	" "
Wrench, 3/8" & 7/16" Hex. (removing & replacing Bank)	Tool #245 ✓	" "
Wrench, 3/16" & 1/4" Hex. for multiple bank setscrew and general use	Tool #43 X	" "
Brush Spring Adjusting Tool	Tool #256 ✓	" "
Socket Wrench, 3/16" Hex.	Tool #220 ✓	" "
Height Gauge (Stop Collar)	Gauge #72 ✓	" "
Brush, Spring Adjusting Tool	Tool #224 ✓	Commutator Brush Rod

*Also used on Sequence Switch.

Tools for Use on Friction Roll Drive.

<u>Name of Tool</u>	<u>Code No.</u>	<u>Used on</u>
Eccentric Bushing Adjusting Wrench 1-3/8 Hex.	Tool #232	Friction Roll Drive
Adjusting Screw Lock Nut Wrench 1-14" Hex.	Tool #247 ✓	" "
Oil sight-gauge Wrench	Tool #238	" "
Wrench for Pivot Screw 1-1/2" Square	Tool #246	" "
Wrench, 1/4" sq. Socket, for sequence switch drive shaft coupling	Tool #254 ✓	" "

Tools for Use on Keys.

Jacks, Lamps, Plugs and Resistances.

<u>Name of Tool</u>	<u>Code No.</u>	<u>Used on</u>
Pliers for large type moulded metal frame key button	Tool #210 ✓	Recording Keys
Pliers for small type moulded metal frame key button	" #211 ✓	" "
Wrench for key button check nut-5/16	" #209 ✓	" "
Spring Adjusting Tool Hex. nut	" #143 ✓	Horizontal Key
Sleeve removing Tool	" #123 ✓	No.49 Jacks
Sleeve inserting Tool	" #124 ✓	" " "

Tools for Use on Keys.

Jacks, Lamps, Plugs and Resistances (cont'd.)

<u>Name of Tool</u>	<u>Code No.</u>	<u>Used on</u>
Spring adjusting Tool (Tip & Ring)	Tool #117 ✓	No. 49 & 92 Jacks
Pin wrench and screw driver	" #103 ✓	No. 16 Jack fastener
Tip Spring Adjusting Tool	" #118 ✓	No. 92 Jacks
Extracting Tool	" #116 ✓	Line & Sup'y lamp
Extracting Tool	" #125 ✓	No. 2 Type lamp
Extracting Tool	" #87 ✓	No. 8 Type Lp. Cap
Extracting Tool	" #112 ✓	No. 2 & 4 Type Lp. Cp.
Adjuster, Lamp socket spring	" #257 X	Lamp Socket Springs.
Wrench, open end 1/4" hex. wired resistance coil	" # ✓	Wired resistances
Wrench, socket 1/4" hex. resistance mounting.	" # 91 ✓	Resistances

Tools for Use on Machine
Switching Frames

<u>Name of Tool</u>	<u>Code No.</u>	<u>Used on</u>
Portable Lamp Fixture	Tool #248 ✓	Machine Switching Frames

Tools for Use on #200-Type Selectors

<u>Name of Tool</u>	<u>Code No.</u>	<u>Used on</u>
Contact Spring Adjusting Tool	Tool #234 ✓	No. 200 Type Selector.
Motor Spring Lug and Contact Spring Bracket Adjusting Tool	" #233 ✓	" " "
Wrench closed end, double ended 3/16" x 5/8" Hex.	" #243 ✓	" " "
Wrench double ended open end 7/16" x 3/8" Hex.	" #244 ✓	" " "